BACKGROUND PAPER 3

MARINE PROTECTED AREAS: THE SOCIAL DIMENSION[1]

by

Robert S. Pomeroy, Michael B. Mascia and Richard B. Pollnac[2]

Summary

The ecosystem-based approach to fisheries management sees the linkages between human and natural systems and recognizes the need for management approaches that address these linkages. One of the most significant new ecosystem-based management approaches is the marine protected area (MPA). MPAs, as management tools, are the product of social institutions. They are human creations whose purpose is to manage the behaviour of people in their use of coastal and marine resources (Bromley 1991). MPAs result from human decision-making processes and establish an incentive structure that requires changes in human behaviour to achieve success. The development, management and performance of MPAs are shaped by a convergence of institutional interests between resource users, resource stakeholders, community, local government, national government, and international agencies. Research suggests that social factors, not biological or physical variables, are the primary determinants of MPA success or failure. It is often more difficult to get the social components of an MPA "right" than the biological or physical components.

Fishers, fishing households and fishing communities worldwide are not homogeneous. It is critical to recognize that each location has its unique social and ecological context that influences MPA design, implementation and impact. This often makes it difficult to transfer lessons from one location to another and to understand behaviour and the incentives that drive behaviour. That said, however, social science has identified some generalities about coastal people and communities which may affect MPA design and implementation, and that are important to take into consideration. Coastal communities in many locations around the world face a growing degree of insecurity as a result of poverty and high dependence upon natural resources. This vulnerability is often compounded by declining resources, high population growth, limited alternative livelihoods, limited access to land, economic and political marginalization, unsustainable land use practices and development, competition and conflicts over resources, health burdens, and civil strife. MPA design and implementation should seek to understand the diversity of coastal people and communities, especially in relation to their livelihood strategies. It also requires understanding the means by which households adapt to reduce their risks, the incentives that drive the decisions of resource users, and the sources of vulnerability to stresses and shocks.

MPAs will have potential benefits and costs to fishers that are realized over both the short and long terms. These benefits and costs will potentially affect the individual fisher, the fisher's household, and the fishing community. The magnitude of the benefits and costs will be affected by the MPAs objectives, size, location, allowed uses, and level of compliance. An important distributional issue with MPAs is that the benefits are diffuse while costs are concentrated. It should be noted that the sociocultural dimensions of MPA performance have not been well studied.

---

[1] This paper was produced for the FAO Expert Workshop on Marine Protected Areas and Fisheries Management: Review of Issues and Considerations (12–14 June, 2006).

[2] The views expressed in this paper are solely those of the authors, Robert S. Pomeroy, University of Connecticut-Avery Point, Groton, CT 06340 USA, Michael B. Mascia, WWF Conservation Science Program, and Richard B. Pollnac, Professor of Anthropology and Marine Affairs, Department of Anthropology, University of Rhode Island, Kingston, RI, USA.

An MPA is a socially constructed set of rules that collectively govern human interactions within a specified area. The design of an MPA is the specific configuration of rules that defines, explicitly or implicitly, *who* may do *what*—and *where*, *when*, and *how* they may do it—with respect to the portion of the marine environment designated as an MPA. The configuration of MPA rules, and the processes through which these rules are developed, implemented, and adapted over time, significantly influences MPA success. The four principal elements of MPA design – decision-making arrangements, resource use rules, monitoring and enforcement systems, and conflict resolution mechanisms – directly and indirectly shape human resource use patterns and, ultimately, the biological and social performance of MPAs. Each of these four MPA design elements may have both formal and informal components derived from diverse sources, including legal statutes, policy statements, judicial decisions, organizational practices, social norms, and cultural traditions. As a result, the *de facto* rules that *actually* govern MPAs often differ sharply from the *de jure* designs established through formal legal structures and policy processes.

A critical factor for success of MPAs is early core group formation, which influences both number of initial trainings and participation, both of which influence introduction of successful alternative livelihoods.

1. INTRODUCTION

In recent years, the ecological collapse and associated social impoverishment of some of the world's best known and most productive fishing grounds (e.g. George's Banks) has fuelled a widespread and growing belief that the conventional fisheries management approaches, with a focus on controlling the exploitation of a single fish stock, is more part of the problem rather than of the solution (National Research Council 1999). Increasingly, it is being recognized that we must incorporate species interactions such as competition and predation, conservation of habitat, and protecting critical life history stages of species and other ecosystem considerations into fishery management (Ecosystem Principle Advisory Group 1999; National Marine Fisheries Service 1999). As a result, the objectives, approaches and policies of fishery management have begun to change. The objectives have shifted from maximizing annual catches and employment to sustaining stocks and ecosystems, and from maximizing short-term interests to addressing both short- and long-term interests. There is a shift away from conventional production and stock- and species-based management toward conservation and ecosystem-based management (Garcia and Newton 1994).

Discussions of marine ecosystems now recognize that they are composed of both natural and human elements. Just as the fish are part of the marine ecosystem, so are the resource users situated within the broad socioeconomic environment. Fish populations are one portion of complex marine ecosystems that are affected by many natural and human-induced factors. In turn, fisheries should be considered as systems in which human systems and ecological systems are linked. This perspective calls for a new way of managing fisheries - an ecosystem-based approach. Ecosystem-based management has emerged as an approach to maintaining ecosystem health and integrity through emphasis on protecting the productive potential and biological diversity of the system that produces goods and services from the ecosystem, as opposed to protecting an individual species or stock as a resource (Costanza *et al*. 1998; NRC 1999; Gislason *et al*. 2000). An ecosystem-based approach to fisheries management is geographically specified fisheries management that takes account of knowledge and uncertainties about and among living marine resources, their habitat, and human components; and strives to balance diverse societal objectives (Sissenwine and Mace 2001). The aim is to ensure that despite variability, uncertainty, and likely natural changes in the ecosystem, the capacity of aquatic ecosystem health is maintained indefinitely for the benefit of present and future generations.

The ecosystem-based approach to fisheries management sees the linkages between human and natural systems and recognizes the need for management approaches that address these linkages. It is also an approach with a human face and a people focus – fishers and fishing communities. One of the most significant new ecosystem-based management approaches is the marine protected area (MPA) (Bohnsack 1993; Roberts and Polunin 1993; Costanza *et al.* 1998; Halpern 2003). An MPA focuses on

protecting an area of the marine environment by limiting or eliminating human activity. IUCN has defined MPAs as "any area of intertidal or subtidal terrain, together with its overlaying water and associated flora, fauna, historical, and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment." (IUCN 1988) The health of the resource is affected by human activities, but also livelihoods and prosperity of people depend upon the condition of the resources. Thus, humans both affect and are affected by the MPA.

The environment in which the MPA operates incorporates economic, social, political and institutional elements at the community, regional, national and international levels, all of which can influence the goals and objectives pursued by the MPA. MPAs are designed and implemented by people, and there are both natural and human impacts from their use. How MPAs perform is directly linked to human behaviour and how humans want them to perform. Thus, MPAs are directly linked to the socioeconomic environment in which they operate.

The purpose of this paper is to discuss the social dimensions of MPA design, implementation, and performance and the relationship between these three elements; and, based on the social dimensions, to provide recommendations for best practices in the use of MPAs. For the purpose of this paper, social dimensions will refer to social, cultural, political, institutional and economic factors collectively. This introductory section will be followed by a section on MPAs as social institutions. This will be followed by two sections that discuss how the social context affects MPAs and how MPAs affect the social context. Issues in MPA design and implementation will be discussed in Section 5. MPA success factors will be discussed in Section 6. The final section will present recommendations for best practices in the use of MPAs.

2. MPAs AS SOCIAL INSTITUTIONS

MPAs, as management tools, are the product of social institutions. They are human creations whose purpose is to manage the behaviour of people in their use of coastal and marine resources (Bromley 1991). MPAs result from human decision-making processes and establish an incentive structure that requires changes in human behaviour to achieve success. The development, management and performance of MPAs are shaped by a convergence of institutional interests between resource users, resource stakeholders, community, local government, national government, and international agencies. Mascia (2004) states that,

> "Marine reserves are not only the product of social processes, but also have social ramifications. Marine reserves, like other forms of resource management, allocate access to and use of marine resources among individuals and social groups and, thereby, directly and indirectly shape society."

Those who are concerned with reorienting fisheries management through MPAs to promote socially-oriented and sustainable policies need to recognize this convergence of institutions and interests if they are to restructure them effectively.

The goals and objectives for an MPA are established by people through various social processes, including a central authority or a consultative mechanism with resources users. Most MPAs have biological, socioeconomic and governance goals and objectives (Pomeroy, Parks and Watson 2004). Biological goals include sustaining or protecting marine resources, protecting biological diversity, protecting individual species, protecting habitat, and restoring degraded areas. Socioeconomic goals include fostering food security, livelihoods, and non-monetary benefits to society, as well as equitably distributing benefits from the MPA, maximizing compatibility between management and local culture, and enhancing environmental awareness and knowledge. Governance goals include maintaining effective management structures and strategies, maintaining effective legal structures and strategies for management, ensuring effective stakeholder participation and representation, enhancing management plan compliance by resource users, and managing and reducing resource use conflicts. Biological, socioeconomic and governance goals may be contradictory or unequally appealing to different constituency groups, resulting in controversy and conflict (Christie *et al.* 2003). These dynamics

contribute to the high rate of MPA failure – approaching 90 percent in some countries (White *et al.* 2002).

Research suggests that social factors, not biological or physical variables, are the primary determinants of MPA success or failure (Fiske 1992; Kelleher and Recchia 1998; McClanahan 1999; Roberts 2000). MPA design and impacts are usually examined from a biological perspective. The focus on primarily biological evaluation criteria may result in an MPA being classified as a success, when, in fact, the reality is much more complex. Christie *et al.* (2003) have stated that,

> "A particular MPA may be both a biological "success" – resulting in increased fish abundance and diversity and improved habitat – and a social "failure" – lacking broad participation in management, sharing of economic benefits, and conflict resolution mechanisms. Short term biological gains will likely disappear unless these social issues are addressed (Pollnac *et al.* 2001; Christie *et al.* 2002)."

3. HOW THE SOCIAL CONTEXT AFFECTS MPAs

As stated above, MPAs are the result of social processes, and are established to change human behaviour by restructuring the incentives that people face in their use of coastal and marine resources. To change human behaviour requires an understanding of the "drivers" of human behaviour. This has often been the weak point of MPA design and implementation.

In general, the design and implementation of MPAs has relied on natural science-driven planning, with limited integration of social science information on resource users, households and communities into the design and evaluation process. This has often resulted in social science information that is "too little, too late", resulting in a poor understanding of frequently contentious social interactions operating on multiple levels (local, national, international, gender, class, ethnicity), unintended negative consequences, missed opportunities for positive change and reallocation of resources, and an incomplete scientific record." (Christie *et al.* 2003) Social science information can help managers identify (Bunce *et al.* 2000; NOAA-CSC 2005):

- Public (and other stakeholders') attitudes, perceptions, beliefs and values
- Use patterns, uses of the marine environment, users of the environment, and relationships between different user groups
- Value of the MPA and the resources
- Impacts of the MPA on the stakeholders and the community
- Relationships between submerged cultural resources and local populations
- Existence of difference in opinion between users and government
- Socioeconomic trends or demographic characteristics
- Informal/traditional marine governance systems
- Social capital

When an understanding of the social context is explicitly integrated into the design and implementation process, it can contribute to MPA management in a number of ways (NOAA-CSC 2005):

Assessment – Managers must have an understanding of conditions before making decisions, by gathering baseline information. Incorporating social science into the assessment process can identify affected groups, as well as potential areas of conflict. Incorporating social science early in the decision-making process can be useful in building upon existing beliefs, values, governance systems, and social structures/capital to foster MPA success.

Feedback – Regular feedback can be helpful in establishing the effectiveness of management techniques and tracking effectiveness over time. Social science research can be used to gauge public perceptions of management focus and effectiveness while also giving the public the opportunity to

suggest management changes. Eventually the feedback process may lead to open dialogue between managers and stakeholders and adaptive management, especially participatory assessment.

Prediction – A range of social science tools, including economic tools and case studies of similar communities, can predict the potential outcomes of management decisions and strategies and enhance management effectiveness.

Mitigation – Identifying stakeholder motivations and areas of concern may help reduce, or even avoid, conflicts among users.

Acceptance – Social science can be used to understand and address public concerns. Concerns can be addressed through changes in MPA management practices or through targeted outreach and education programs, which may lead to increased support from the public and constituents.

3.1 Understanding coastal people and communities

Fishers, fishing households and fishing communities worldwide are not homogeneous. It is critical to recognize that each location has its unique social and ecological context that influences MPA design, implementation and impact. This often makes it difficult to transfer lessons from one location to another and to understand behaviour and the incentives that drive behaviour. That said, however, social science has identified some generalities about coastal people and communities which may affect MPA design and implementation and that are important to take into consideration.

Coastal communities in many locations around the world face a growing degree of insecurity as a result of poverty and high dependence upon natural resources. This vulnerability is often compounded by declining resources, high population growth, limited alternative livelihoods, limited access to land, economic and political marginalization, unsustainable land use practices and development, competition and conflicts over resources, health burdens, and civil strife. MPA design and implementation should seek to understand the diversity of coastal people and communities, especially in relation to their livelihood strategies. It also requires understanding the means by which households adapt to reduce their risks, the incentives that drive the decisions of resource users, and the sources of vulnerability to stresses and shocks (Pomeroy *et al.* 2006).

3.1.1 Diversity

Although the dominant livelihood in many coastal communities, capture fishing is not the only livelihood. Indeed, even when fishing and agriculture are accounted for, all the other livelihoods (ranging from fish-processing to tourism) combined can employ an equal or greater number of people in many coastal communities. These other livelihoods are also likely to employ a wider mix of persons, including women and those from non-fishing communities that live near the coast.

As stated above, coastal communities and the people who live in them are not homogeneous. Even within a single community, coastal resource users may have quite distinct economic orientations. They may be full-time, part-time, seasonal or migratory, and coastal households may have a commercial or subsistence orientation. Livelihoods may be based on a subsistence, "satisficers" (fishing to obtain 'enough income'), or wealth creation/profit-maximizing goal and on a diversified or specialist strategy (Charles 2001; Smith *et al.* 2005). Within the community and groups within the community, there may be differences in internal social cohesion (feelings of attachment to the community or group).

3.1.2 Adaptation

Many households in coastal communities undertake a range of activities in order to cope financially and reduce the risks associated with high economic dependency on natural resources (Bailey and Pomeroy 1996; Allison and Ellis 2001). Fishing itself is a diverse occupation, with many fishers operating in multi-species and multi-gear fisheries. Existing livelihood strategies may be modified or new strategies adopted to meet changing conditions.

It is important to focus not only on the resource user but also on the whole household and household livelihood strategy. For example, all or some of the family members may engage in different livelihood activities. Depending on economic, resource and environmental conditions, these activities may change temporally and spatially throughout the year. The household livelihood strategy may be based on relationships between the extended family or within the nuclear family.

The household livelihood strategy mix will depend upon season, access to the resource (whether fishing areas or farm land), access to capital, skill base, education, and risk preference. Coastal residents may also engage in illegal activities for livelihood, such as dynamite fishing, smuggling or poaching inside MPAs. Rather than being specialized, and therefore vulnerable to a sudden change, many households in coastal communities are well situated to adapt to changing circumstances. The net result of this occupational diversity is that many coastal communities are best understood as dependent not on a single resource but on a whole ecosystem, marine and terrestrial.

Fishers in Southeast Asia, for example, generally like their occupation, despite the risks, and few would change to another occupation with similar income (Pollnac *et al.* 2001). Those most likely to leave fishing for another occupation tend to obtain less of their income from fishing and coastal activities and to have more education. If it is deemed appropriate to provide an alternative occupation that is attractive to fishers, it should, at least, have some of the same characteristics as those considered desirable in fishing. These characteristics include the relative ease of obtaining food and income, the pleasure of being at sea, and the independence of being self-employed. A common alternative livelihood considered for fishers is aquaculture. Evidence exists that fishers would consider aquaculture as an alternative source of food and income, especially if the cost of the technology was low, income was good, and other family members could be involved in the operation (Pomeroy 2004).

3.1.3 Incentives

The incentive structures that individuals and households face are partly economic and partly related to other external factors, such as property rights, rules governing resource use, and levels of enforcement. Many coastal resource users exist at the subsistence level and have a short-run survival strategy of taking care of the daily needs of themselves and their family. These resource users (e.g. fishers), due to limited capital mobility and lack of alternative livelihoods, will use whatever resources are available to them (technology, skill, capital) in order to harvest as much of the resource as possible. These resource users have what is called a *high discount rate* concerning use of the resource – they prefer profits and food now over a continual flow in perpetuity (Pomeroy 1991). This behaviour results in unsustainable levels of resource extraction and reduced profitability. Implementation of an MPA in the context of this economic uncertainty will only shift the problems of competition and conflict into other areas. Until the base issues of resource tenure, excess fishing capacity, and the race for fish are resolved, the ability of the MPA to improve management effectiveness will simply be a stop-gap measure.

Cultivating an awareness of the problems of unsustainable resource use is therefore only a small first step. The more difficult and vital work involves shifting the incentives that resource users face. This includes efforts that build on the array of opportunities and resources at people's disposal – so that they become less directly dependent on the local natural resources for their daily subsistence – and strengthen their security of tenure (whether private or communal) – so that users have a greater stake in a longer-term perspective.

Recognition must also be made between individual decisions and the achievement of broader community and/or societal objectives. Charles (2001) states:

> "Consider the reality in many fisheries, located in regions of isolated fishing communities, where few alternative employment possibilities are available. Often the maintenance of sustainable livelihoods, i.e. stable employment with reasonable incomes, is a priority among society's fishery objectives. This is not just a matter of providing jobs in the fishery, but also of maintaining a

strong 'engine' of the coastal economy, given the extent of spin-off benefits from the fishery into coastal communities." (p. 67).

3.1.4 Vulnerability

The physical isolation of some coastal communities makes them highly resource-dependent and reduces access to alternative livelihoods; this can make them especially vulnerable to any disruptions. Yet even physical isolation can be mitigated through appropriate improvements to infrastructure, health and education services, and improved access to information and markets.

Some aspects of household vulnerability vary with the seasons. While occupational diversification may allow households to maintain a level of income throughout the year, there may be periods of high income (as when crops are harvested or fishing is good) and low income (as when fishing is poor or not possible due to storms). A household's ability to weather these slack periods depends also on the availability of other sources of income, including remittances from family members living outside the area, informal loans from money lenders or traders, and systems of mutual support at the community level.

Other root causes of vulnerability in coastal communities are social and economic power imbalances, lack of participation in decision-making, limited asset ownership, resource dependence, and laws and regulations that influence people's ability to use assets. Once the root causes of vulnerability are recognized, interventions can be put in place to address them and to increase the resilience of the community to shocks, seasonal factors, and human and natural changes. Building resilience means, in part, reducing reliance upon natural resources for livelihoods, strengthening community institutions, organizations and infrastructure, and diversifying livelihoods.

3.2 Perception, attitudes and incentives

Fishers will tend to oppose the establishment of MPAs. (Although it should be stated that there are many instances of fishers establishing MPAs or seeking help to do so, either as a way to establish preferential use rights [i.e. reduce competition with "outside" fishers] or to catalyze transition out of a fishing economy [through tourism]). This is due to the issues discussed above, as well as their experience with past management measures, their natural antagonism towards and suspicion of managers and regulators, and their concerns about resource rights and access reallocation. Any management measure is, rightly or wrongly, most often perceived by fishers as being costly to them by limiting their ability to fish and earn a living. Any proposal to restrict use of the sea will always be controversial. Information about the MPA is shaped and reshaped into many forms by different stakeholder groups, and it is often very difficult to change once positions have been established. Communication about the purpose and intent of the MPA must be clear and transparent and presented early in the process so that any misperceptions can be addressed. Different perspectives of individuals and local groups will need to be understood and considered.

If people, individually and as a group, feel that they have not been part of the decision-making process of the MPA, and have not been able to actively participate in and influence the process, it will be difficult to obtain support and compliance. The attitudes of the group will tend to be negative towards the MPA. Compliance with the MPA rules appears to be based on a combination of three principal factors: coercion, self-interest, and legitimacy (Mascia 2000).

Controversy and conflict are associated with almost all MPAs because they reallocate resources (and wealth) within and among groups. Attitudes of all stakeholders towards the MPA will need to be understood and followed, as they will shift over time. An understanding of the basis of the conflict, whether due to data and facts, needs and interests, values, and/or relationships, will need to be made. Attitudes toward various approaches to conflict management and willingness to compromise should be assessed (Pomeroy and Rivera-Guieb 2006).

Fishers will be concerned about equity issues and the redistribution of benefits and costs resulting from this new management measure. A perception of MPAs is that fishers will give up benefits from an area in exchange for highly uncertain future returns. Traditional access rights in an area may be disrupted or accustomed uses of resources will be reallocated to other uses and users. There is often the perception that MPAs are highly subject to political manipulation (Zinn and Buck 2001).

Perceptions and attitudes towards MPAs will also be shaped by cultural traditions and values. Different groups of resource users and stakeholders may hold different, or unexpected, positions regarding MPAs and marine resources due to their uses of the resource, culture, family and community traditions, beliefs, expectations about the future, environmental knowledge, and the value that they put on the resource.

Individuals will require an incentive structure (economic, social, political) to participate in the MPA and the process of design and implementation. Individuals must have a sense that the rules in place for the MPA are equitable and there must be sharing of costs and benefits among all the stakeholders. Individuals must feel that the benefits to be obtained from participation in the MPA, including compliance with rules, will be greater than the costs of such activities. Individuals must also trust in protected area management (Stern in press). The MPA often involves the individual giving up short-term benefits for real or perceived longer-term benefits. For the individual, the cost of participation, especially in terms of the time involved, cannot be too high or participation will fall. Often, the short-term costs are high in terms of lost income or voluntary labour. For a poor fisher with a family to feed, the incentive structure to support and participate in the MPA must be clear and large. Risk is involved for the individual in changing management measures. The fisher must recognize an incentive for the support of the MPA and long-term stewardship for the resources before the design and implementation process begins. The incentive may simply be the hope for a better tomorrow, but usually changes as the individual gains more information and as the process develops over time. It is often easier to design and implement an MPA where the individual already recognizes an incentive for changing management, rather than pushing change on the individual. Different incentive structures may appeal to different individuals. The incentive may be economic, in terms of higher income, food security, jobs, or protection of livelihoods. It may also be social, in the form of higher prestige among peers or legitimate access to resources (Pomeroy *et al.* 2001).

Incentives should also include real economic benefits. MPA projects should not just focus on resource management, which may take years to show benefits. Combining resource management with livelihood opportunities that provide economic benefits in the short-run are useful to address any economic disruptions to the individual or household. This will be an important incentive for participation and long term sustainability of the MPA (Pomeroy *et al.* 2005).

3.3 Socioeconomic assessments

A socioeconomic assessment is a way to learn about the social, cultural, economic and institutional context and conditions of individuals, groups and communities. There is no fixed list of topics that are examined in a socioeconomic assessment, however, the most commonly identified topics are (Bunce *et al.* 2000; NOAA-CSC 2005):

- Resource use patterns
- Stakeholder and community characteristics
- Gender issues
- Stakeholder perceptions, attitudes and beliefs
- Organization and resource governance and governance processes
- Traditional knowledge
- Community services and facilities
- Market attributes for extractive use
- Market attributes for non-extractive use
- Non-market and non-use values

Socioeconomic assessments vary in the extent they cover these topics, and this will depend on the purpose of the assessment. Some socioeconomic assessments may be a full evaluation of all these topics; others may focus on only one topic such as stakeholder perceptions or resource use patterns. As with all sciences, when conducting a socioeconomic assessment, the reliability and credibility of any information is dependent on the precision of the data collected and the accuracy of the method of analysis. The types of socioeconomic assessments differ, and they can be characterized by two main characteristics (Bunce *et al.* 2000):

- Whether they are participatory (a broad range of people involved in data collection, analysis and use) or extractive (outsiders conduct the assessment and take the information with them)
- Whether they are product-oriented (report produced for specific stakeholder group) or process-oriented (the process of collecting information is as important as the information)

4. HOW MPAs AFFECT THE SOCIAL CONTEXT

MPAs serve as a resource reallocative mechanism, within and among groups of resource users, and at varying spatial and temporal scales. As such, MPAs can either help or hurt local people and communities around them depending upon how they are designed and implemented. As CANARI (2005) state:

> "But realistic assessments of the impacts of MPAs on local households have not been part of official planning processes, and planners are often surprised when fishers resist the establishment or expansion of MPAs because they fear, often with justification, that access to their fisheries will be restricted or cut off completely. The establishment of MPAs thus often results in conflicts between fishers and state agencies. It can also create or increase tensions between fishers and tourism sectors, since objectives and programs of MPAs often are skewed in favor of tourism at the expense of other sectors."

MPAs will have potential benefits and costs to fishers that are realized over both the short and long terms (Dobrzynski and Nicholson 2003; Goodridge *et al.* 1996; Mascia 2000; McClanahan and Mangi 2000; Sanchirico *et al.* 2002). These benefits and costs will potentially affect the individual fisher, the fisher's household, and the fishing community. The magnitude of the benefits and costs will be affected by the MPAs objectives, size, location, allowed uses, and level of compliance (Thomson 1998). An important distributional issue with MPAs is that the benefits are diffuse while costs are concentrated (Hanna 2004). It should be noted that the sociocultural dimensions of MPA performance have not been well studied.

An obvious potential benefit to fishers from an MPA that is able to stabilize or increase fish populations inside its boundaries and produce spillover effects is reduced variations in aggregate catch levels and an increase in the long-run total catch (Sanchirico *et al.* 2002). Sanchirico *et al.* (2002) state that, "MPAs can also increase the market value of a fishery by changing the composition of the catch." Another possible increase in revenues could occur if the changes in catch composition from smaller to larger fish are accompanied by a shift to a more valuable product form (such as frozen to fresh product) (Sanchirico *et al.* 2002). A potential cost to the fisher is that catch, and revenues, may be decreased, at least in the short-term, as a result of the implementation of the closure. The coastal community adjacent to the MPA, especially those with a high economic dependency upon the fishery, may face a disproportionate impact, particularly in the short-term, as a result of aggregate reduction in fishing revenue.

McClanahan and Mangi (2000) report a 60 to 80 percent decline in the number of fishermen at the Jomo Kenyatta Beach fish landing site following establishment of the no-take Mombasa Marine Park in Kenya. Many displaced resource users gain full or partial employment in other sectors, such as construction or tourism, but older fishermen, in particular, appear less able to take advantage of

alternative economic opportunities. Marine reserves may also induce new migration patterns by restructuring economic opportunities, drawing people to local communities in the case of some reserves and displacing them from adjacent communities in other situations. These shifting migration patterns frequently change the demographic profile of user groups and coastal communities. Perceptions of individual, household, and community well-being appear to vary by stakeholder group and depend largely upon the distributive economic impacts of reserves (Mascia 2000). No known research has examined the impact of marine reserve establishment upon social indicators such as rates of crime, domestic violence, or alcoholism, demonstrating the need for further study.

Research suggests variation in the social impacts of MPAs on the four principal dimensions of poverty: wealth, health, political empowerment, and education. With respect to wealth, MPA establishment generally induces shifts in resource access and use that vary within and among social groups. Often these shifts involve changes from extractive activities (e.g. fishing) to non-extractive activities (e.g. ecotourism) and/or local resource users moving to exclude "outsiders" (users from outside the immediate community) from accessing nearby marine resources. For those gaining preferential resource access, MPA establishment has often resulted in increases in income, food security, and material assets, while those losing access may suffer corresponding losses or adopt mitigation strategies by shifting resource use patterns or livelihoods strategies. (Resource users engaged in mobile forms of resource use, for example, have greater flexibility to respond to shifting marine resource governance regimes [e.g. MPAs], and are therefore better able to mitigate negative impacts and capture benefits.) The social impact of MPAs on health, political empowerment, and education are poorly studied, though one might expect that changes in these dimensions of poverty would generally follow shifts in patterns of access to MPA resources. Variation (spatial, temporal, and across MPAs) in the magnitude and extent of these MPA social impacts remains largely unexamined and unexplained, highlighting the need for further study to better understand the role of MPAs in poverty alleviation (Mascia *et al.* in preparation).

The establishment of the MPA will result in a reduction of area that is available for fishing. This could potentially result, at least in the short run, in higher levels of congestion and fishing effort in the remaining areas (Hanna 2004). Fishers may also be forced to travel to other, sometimes more distant, fishing grounds (NRC 2000). The effects could be higher fuel, labour and other operating costs and potentially increasing capital expenditures in the fishery (e.g. the need for larger boats and engines and new technology such as GPS). This could increase the hardships on local fishers, especially the poorest of fishers. As Mascia (2004) states:

> "Measures of relative change in income, wealth, or wealth disparity among specific groups or subgroups (e.g., fishermen and divers, line fishermen and net fishermen), for example, represent useful indicators of the distributive economic effects of reserve establishment. The effect of marine reserves on economic equity may also be measured using indicators that track the net economic effect of reserves on populations of particular concern, such as women, minorities, the poor, the elderly, or traditional cultures. The geographic distribution (e.g., local versus national) of costs and benefits is also a useful indicator of the economic equity of a marine reserve."

Sanchirico *et al.* (2002) explore these social issues further, noting that,

> "In addition, significantly reducing the amount of fishable waters could lead to increased conflicts between users of the resource, such as allocation disputes and gear entanglements. … Congestion effects might not only be concentrated in the fishery for which the closure was implemented, as establishment of an MPA could shift fishing pressure from one species to another, thereby increasing the competition for the catch of that second species."

The establishment of MPAs potentially creates short-term losses and hardships for fishers. It has been suggested that short-term economic assistance, through compensation, should be explored to address these losses. There is disagreement about whether or not it is appropriate to compensate fishers for the loss of access to a public resource (Rettig 1994). Compensation may be offered in the form of cash to

loans, vessel buy-back to re-training, or joint venture contracts (Roberts and Hawkins 2000). Advantages of compensation include better (uncontested) outcomes, higher levels of support and compliance, reduction in long-term transaction costs, and government consideration of the opportunity costs of actions (Rettig 1994).

Shifts in fishing grounds and travel time as a result of the MPA may potentially result in increased occupational risks to the fishers (Sanchirico *et al.* 2002). The combination of inadequate vessels and lack of experience of the displaced fishers to operate in the new environments poses the potential for greater occupational risks.

MPAs have been shown to increase fish stock abundance, biodiversity and recovery of habitats. As a result, MPAs can be highly attractive to non-extractive users who value the biological and cultural resources for their tourism and recreational opportunities. New visitors can lead to diversification of the local economy through new businesses, jobs and income and tax revenues for the local community. Potential increases in revenue from visitors could lead to potentially offsetting losses to fishers due to the MPA (Sanchirico *et al.* 2002) and help to finance MPA management. Improvements in the environment of the MPA "… may also appeal to individuals who might never intend to use the area, but who value its existence nonetheless." (Sanchirico *et al.* 2002) MPAs can reduce potential conflicts between fishers and other users by providing areas where non-fishery users can pursue non-consumptive uses of the resources.

Excessive visitation of MPAs, and the development that can accompany tourism, can be damaging to the environment and reduce the biological, cultural and economic benefits obtained from the closure. It is important to monitor and manage MPAs to ensure that sustainable levels of tourism are not exceeded (Roberts and Hawkins 2000).

Fishers could potentially face the loss of customary access to fishing areas as a result of the MPA. Local fishers who do not have the resources to fish in another location could be forced out of the fishing business. Alternative or supplementary livelihood opportunities may not be available for all fishers and their families as a result of economic base shifts in the community, increasing hardships to many (Sanchirico *et al.* 2002). Some community members may be negatively impacted as a result of economic changes in the community, such as tourism, and the lose of their traditional way of life (Hoagland *et al.* 1995).

The effects of MPA establishment on economic equity are perhaps even less well understood and less well studied than reserve effects on efficiency. Among those MPAs that permit non-consumptive uses, the general qualitative pattern that follows MPA establishment is a transfer of direct use benefits from consumptive resource users such as fishermen to non-consumptive users such as dive operators and scientists. In Barbados, for example, establishment of the Barbados Marine Reserve shifted the local system of resource use rights from a virtual "open access" system that permitted both consumptive and non-consumptive uses to an ecotourism and scientific use regime that allowed only non-consumptive uses (Mascia 2000). Among MPAs that prohibit both consumptive and non-consumptive uses, all direct users incur costs associated with the loss of resource use rights within the reserve. In this instance, equity indicators include measures of the relative magnitude or significance of the costs incurred by user groups or populations of particular concern (Mascia 2004).

Among both consumptive and non-consumptive users, the distributive economic effects of reserve establishment vary by subgroup. In St. Lucia, for example, establishment of the Soufriere Marine Management Area affected net fishermen and trap fishermen differently (Goodridge *et al.* 1996). In general, small scale fishermen, especially those who use fixed gear or fish within informal fishing territories, are more vulnerable to the loss of fishing grounds than larger scale, transient fishermen employing mobile gear. Small-scale and territorial fishermen, when affected by reserve establishment, lose a larger percentage of their fishing grounds than large-scale or transient operators. The latter groups, however, may be more likely to lose a portion of their fishing grounds to MPAs simply because they fish a larger geographic area. The distributive economic impact of reserve establishment

on non-consumptive users appears correlated with users' degree of economic dependence upon the natural environment. Dive operators, for example, are more likely to benefit from reserve establishment than jet-ski businesses (Mascia 2004).

5. MPA DESIGN AND IMPLEMENTATION[3]

As mentioned previously, MPAs are social institutions. In essence, an MPA is a socially constructed set of rules that collectively governs human interactions with a specified area of the marine environment. Rules define MPA boundaries, the activities that may take place within these boundaries, and the individuals who may engage in MPA activities. Rules also specify protocols for enforcing MPA rules, monitoring the effectiveness of these rules, and for resolving stakeholder conflicts. Most importantly, rules govern the decision-making processes that establish MPA boundaries, resource use rights, monitoring and enforcement systems, and conflict resolution mechanisms. Thus, the design of an MPA is the specific configuration of rules that defines, explicitly or implicitly, *who* may do *what*—and *where*, *when*, and *how* they may do it—with respect to the portion of the marine environment designated as an MPA. The configuration of MPA rules and the processes through which these rules are developed, implemented, and adapted over time, significantly influence MPA success (see Section 6).

The four principal elements of MPA design – decision-making arrangements, resource use rules, monitoring and enforcement systems, and conflict resolution mechanisms –directly and indirectly shape human resource use patterns and, ultimately, the biological and social performance of MPAs. Each of these four MPA design elements may have both formal and informal components derived from diverse sources, including legal statutes, policy statements, judicial decisions, organizational practices, social norms, and cultural traditions. As a result, the *de facto* rules that *actually* govern MPAs often differ sharply from the *de jure* designs established through formal legal structures and policy processes. Commercial fishing continues in Glacier Bay National Park (Alaska, United States), for example, despite legal prohibitions dating to 1966 (NRC 2001; 156–157).

5.1 Decision-making arrangements

MPA decision-making arrangements specify the rights of individuals or groups to make choices regarding other aspects of MPA design and management. These rules determine, for example, who may participate in making decisions and who may not (e.g. government officials, resource users), how decision makers are selected for their positions (e.g. elected or appointed), and how decisions are made (e.g. consensus or majority vote). MPA decision-making rules are significant because policy preferences often vary among individuals or social groups; the particular structure of decision-making arrangements determines whose interests, beliefs, and values are represented in decision-making processes and thus manifest in policy and management decisions. During the development of the Florida Keys (United States) National Marine Sanctuary management plan, for example, commercial fishermen shared limited decision-making authority with environmental groups and commercial dive operators, among others. Commercial fishermen generally opposed the establishment of no-take areas as part of the Sanctuary management plan, whereas environmental groups and commercial dive operators generally supported widespread no-take areas (Suman *et al.* 1999). Had any of these groups held exclusive decision-making authority, its policy preferences alone would likely have been reflected in the Sanctuary management plan. In practice, the system of shared decision-making authority resulted in a policy compromise—immediate establishment of a system of nearly two dozen relatively small no-take areas within the Sanctuary and a commitment to develop a larger no-take area at a later date.

MPA decision-making arrangements are usually complex. The responsibility and authority for decision making often rests with different (though frequently overlapping) sets of individuals or

[3] This section is adapted from and builds upon Mascia (2004).

groups during the different stages of the policy process (i.e. agenda-setting, assessment, selection, implementation, evaluation, and termination; Brewer and deLeon 1983). The decision-making rights of particular groups are sometimes limited to narrow aspects of MPA development or management (e.g. enforcement, conflict resolution). Procedural rules that govern voting, decision-making criteria, and the use of scientific information also vary depending upon the stage in the policy process. At each stage, subtle differences in the rules that govern MPA decision making may have significant impacts upon MPA design, implementation, and evaluation.

MPA decision-making arrangements range along a continuum from highly centralized to highly participatory. Centralized decision-making arrangements limit decision-making responsibility and authority to a single individual or a small group, often specialists within a single government agency. Participatory decision-making arrangements, by contrast, permit sharing of decision-making responsibility and authority among diverse groups: resource users; nongovernmental organizations; local, state, and national government officials; and other stakeholders.[4] Because the amount, diversity, and type of information brought to bear upon decisions depends upon who has the right to participate in decision-making processes (Healy and Ascher 1995), participatory MPA decision-making arrangements generally increase the amount and diversity of information integrated into MPA design and management. Participatory MPA decision-making arrangements thus increase the likelihood that policy decisions will be based upon accurate assessments of social conditions and environmental dynamics.[5] Participatory MPA decision-making arrangements also tend to enhance the perceived legitimacy of decisions (Dalton 2005). The proposed boundaries of the Hol Chan Marine Reserve (Belize), for example, were revised prior to implementation at the request of local fishermen, which enhanced the legitimacy of the MPA in the eyes of affected individuals (Mascia 2000).

In particular, participatory MPA decision-making arrangements create mechanisms for integration of traditional or local ecological knowledge into MPA design (Dalton 2005).[6] This collective knowledge, based upon centuries of resource use or much more recent interactions with the environment, can promote more effective MPA design by bringing information not captured by formal science into the decision-making process. In particular, local knowledge may help to contextualize general scientific understandings of natural and social phenomena. Local knowledge, for example, frequently serves as the basis for identifying ecologically and socially significant marine areas (e.g. fish spawning aggregations, sacred sites) that merit protection within MPAs (McClanahan and Glaesel 1997; Heyman and Graham 2001).

The procedural rules that govern how decision-makers make choices can shape the results of MPA decision-making processes. Voting rules shape the balance of power between majority and minority interests. Decision-making by consensus, for example, grants significantly more power to minority interests than decision-making by simple majority. Voting rules also shape perceptions of the legitimacy of decision-making processes among both minority and majority groups. Similarly, the rules and criteria established to govern decisions (e.g. requiring a specific percentage of the coast be designated as MPAs) often shape the outcome of decision-making processes.

---

[4] We use the term *resource user* to refer to individuals who derive consumptive or non-consumptive benefits from their physical interactions with the marine environment. The term *stakeholder,* which includes but is not limited to resource users, refers to individuals and organizations with a significant interest in the marine environment or its management.

[5] Though little studied, organizational culture may play a significant role in MPA design. Centralized MPA decision-making processes, in particular, may allow the particular beliefs and values held by a government agency or other decisionmakers to predominate – and potentially result in ineffective policy choices because of incorrect assumptions regarding how the world works or policy preferences out of step with those of other stakeholders (Mascia 2000). Participatory processes allow for diverse perspectives and information exchange that can challenge the foundations of organizational culture and foster more effective MPA design.

[6] Traditional ecological knowledge is "a cumulative body of knowledge, practice and belief evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment" (Berkes *et al.* 2000: 1252).

In some situations, the absence or delegation of formal government-led MPA decision-making arrangements creates opportunities for resource users to establish MPAs and manage their own resources collectively. Historically, resource user self-governance was common, leading to the emergence of MPA-like marine resource management systems throughout Melanesia and elsewhere in the tropics (Ruddle 1996). Though emergence of stronger central government governance of marine resources eroded the authority of local resource users in colonial and post-colonial periods (Johannes 1978), a legacy of local user-based marine resource management remains in many coastal communities (Ruddle 1996; Johannes 2002). The frequent failure of governments to meet the challenge of marine resource degradation has led many resource users to reassert decision-making authority over marine resources, resulting in establishment or re-establishment of user-based MPAs in coastal communities around the world (Woodley and Sary 2003; Hoffman 2002; Johannes 2002).

The structure of MPA decision-making arrangements has a significant effect upon reserve performance. In MPAs and analogous natural resource governance regimes, research demonstrates that the right of resource users to participate in the design and modification of rules governing resource use is correlated with regime performance - environmental and social (Christie and White 1997; Mascia 2000, 2003; Ostrom 1990; Pollnac *et al.* 2001). Research also suggests that resource user self-governance rights (i.e. the right to govern the behaviour of one's group, independent of external authorities) are correlated with reserve establishment and performance (Mascia 2000, 2003). Selecting basic rules and criteria to govern decision making (i.e. process guidelines) before attempting to make substantive choices about reserve design may help to reduce conflict and facilitate informed decisions among stakeholders with diverse interests, beliefs, and values (Mascia 2003).

5.2 Resource use rules

Rules governing resource use are the second principal element of MPA design. Resource use rules—including laws, regulations, formal and informal policies, codes of conduct, and social norms—specify the rights of individuals or groups to access and appropriate resources. These rights may be held by individuals, groups, organizations, or the state, and are often shared among these actors. Moreover, resource use rights are seldom absolute. The United States government, for example, may alter the resource use rights of individuals without compensation when legitimately exercising its public trust authority. Though the right to change the rules governing resource use is generally held by governments, this decision-making authority may be shared with or delegated to resource users or other stakeholders. In the state of Maine (United States), for example, lobster fishermen are governed by formal laws and informal codes of conduct that specify where, when, and how they may fish. The Maine state government granted lobstermen limited decision-making authority over resource use rules, including the right to specify trap limits, through the establishment of regional lobstermen-only "councils" (Acheson 2003).

MPA rules governing resource use thus specify how individuals may interact with each other and with the marine environment. Infinite possible configurations of resource use rules exist, ranging along a continuum from "open access" (i.e. no rules) to a complete prohibition on human activities. MPAs generally fall into one of three broad categories: no-take MPAs, zoned multiple use MPAs, and unzoned multiple use MPAs (see Figure 1). No-take MPAs prohibit all consumptive uses of marine resources and sometimes non-consumptive commercial, recreational, and scientific activities as well.[7] Zoned multiple use MPAs establish sets of defined, spatially-explicit rules that allow for different uses of the marine environment in different portions (zones) of the MPA. Unzoned multiple use MPAs, by contrast, establish use rights that differ from the surrounding marine environment, but do not create spatial boundaries within the MPA. Within each of these three categories, MPA rules governing resource use vary in subtle but significant ways. The Florida Keys (United States) National Marine

[7] No-take MPAs are frequently referred to as *marine reserves*, but in some parts of the world "reserves" allow fishing and other forms of extractive resource use. Similarly, marine "parks" and "sanctuaries" permit consumptive resource use in some countries and prohibit all consumptive resource uses in other countries. In discussing marine resource rules, therefore, we prefer to use the generic term "MPA" and to refer to specific permitted and prohibited resource uses.

Sanctuary, for example, has several categories of regulatory zones, including three types of no-take zones, each of which has a different policy objective.

Rules governing resource use shape MPA performance by establishing use rights that foster specific policy outcomes. Because it is impossible to maximize multiple policy objectives simultaneously, the design of MPA rules reflects tradeoffs among social, economic, and environmental goals. No-take MPAs, for example, may reflect decisionmakers' efforts to promote tourism development by setting aside areas for recreational activities, whereas zoned multiple use MPAs may represent efforts to mitigate conflict among resource users by physically separating the relevant parties. Despite efforts to promote specific policy outcomes, MPAs frequently shape human behaviour in unanticipated ways and result in unanticipated social and environmental impacts.

The precision and stability of resource use rights mold individual behaviour. Precise MPA rules specify *who* may do *what, where*, *when,* and *how*. This precision minimizes conflict among resource users or between resource users and enforcement personnel. In some MPAs, for example, dive operators may only use particular dive sites at assigned times; such arrangements prevent crowding and conflict among users. MPA rules facilitate non-compliance and foster conflict when they are unclear or contested (Erdman and Bishop 2003), which raises the costs of resource use and dissipates the benefits of use to resource users. Likewise, imprecise and unstable resource use rights create uncertainty over future opportunities, causing users to discount the future sharply and exploit resources more heavily than they otherwise would. Well-defined resource use rights—precise, stable, easily understood, and easily enforceable—enhance the economic benefits and environmental sustainability of MPAs by reducing social conflict and creating greater certainty regarding future resource use.

Since resource use within MPAs is spatially-defined, rules defining internal and external MPA boundaries are critical to the establishment of precise resource use rights. MPA boundaries are often formally delineated by geographic coordinates (i.e. latitude and longitude) delineated in law or agency regulations. Authorizing legislation and MPA management plans also frequently include provisions for the physical demarcation of MPA boundaries with floating buoys and other markers. For resource users who do not have access to technologies that allow easy geo-referencing based on latitude and longitude alone (e.g. GPS), physical representation of MPA boundaries is necessary for clear definition of resource use rights. In many smaller-scale MPAs, particularly those based on traditional marine resource management systems, boundaries are often effectively delineated by physical markers, underwater features, and landmarks.

MPA rules defining human "boundaries" are equally critical to the establishment of precise resource use rights. By specifying who may and who may not engage in particular forms of resource use, MPA rules effectively allocate marine resources to a subset of privileged individuals (communities, user groups, social classes, etc.). The distributive equity of MPA rules directly shapes MPA social impacts by structuring access to the wealth associated with marine resource extraction (Mascia 2000), with obvious implications for the ability of MPAs to achieve specific policy outcomes (e.g. alleviate coastal poverty). In addition, the distributive structure of MPA rules indirectly shapes MPA effectiveness by influencing resource user perceptions of MPA legitimacy and subsequent compliance with these rules (see below).

Designing precise MPA rules also requires reconciling MPAs rules governing marine resource use with pre-existing marine resource governance systems. Establishment of MPA rules rarely occurs in a governance vacuum. Formal government management systems regulate marine resource use in most countries; in many coastal areas, resource users have also developed rules to govern marine resource use. Failure to reconcile novel MPA rules with existing regulations may foster uncertainty, non-compliance, accelerated resource use, and conflict among resource users (Erdman and Bishop 2003). By contrast, using existing governmental and resource user governance systems as the foundation for MPA rules can enhance understanding, support, and compliance among resource users and government officials.

Research demonstrates that the clarity and congruence of rules governing resource use influence MPA performance. Clearly defined resource and reserve boundaries, as well as clearly defined individual resource use rights, tend to improve the social and environmental performance of MPAs and other natural resource governance regimes (Ostrom 1990; Mascia 2000, 2001). Rules governing resource use that are explicitly linked to local conditions also tend to enhance reserve performance (Mascia 2000). Research also suggests that the presence of economically congruent resource use rights—where the resource users who benefit most from reserve establishment bear the greatest cost of sustaining reserve benefits, while those who derive the fewest benefits incur the least cost—foster MPA performance (Mascia 2000). Among effective MPAs, research suggests that the rules governing resource use have sufficient scale and scope to address all threats that significantly affect the social or environmental systems of the reserve (Mascia 2000). Finally, the performance of legally designated MPAs tends to be enhanced when reserve resource use rights are consistent with existing informal or culturally based resource use rights (Fiske 1992; Mascia 2000).

5.3 Monitoring and enforcement systems

MPA monitoring systems track changes in the state of MPA-associated social and environmental systems. MPA monitoring systems vary in what they measure and who does the measuring, as well as where, when, and how measurements are made. Carefully designed monitoring systems— which generally include robust performance indicators, baseline data, and control sites—can provide insights into the changes in social and environmental systems due to MPA establishment. Participatory MPA monitoring systems, which involve resource users and other non-scientists in formal data collection and analysis, provide a mechanism for increasing awareness, improving resource management, and empowering communities (Obura and Wells. 2002). In practice, many MPAs lack formal systems for monitoring environmental and, especially, social phenomena. As a result, resource users, managers, and other stakeholders often informally monitor environmental and social indicators to assess MPA performance. Monitoring-based assessments of performance can guide future MPA policy and management decisions, as well as enhance confidence in current policies and management practices. In Belize, for example, formal and informal assessment of the social and environmental performance of the Hol Chan Marine Reserve led to widespread support for expansion of the MPA (Mascia 2000).

Enforcement systems attempt to increase compliance with rules governing resource use by monitoring user behaviour and punishing those engaged in prohibited activities. By increasing the severity and likelihood of sanctions and, thus, raising the opportunity cost of non-compliance, enforcement systems act directly upon resource users to foster adherence with established rules. Monitoring user behaviour forces would-be poachers to engage in deceptive practices that diminish the benefits of engaging in prohibited activities. Sanctioning non-compliance further diminishes the benefits of engaging in prohibited activities and thus deters malfeasance. The role of enforcement systems has been demonstrated in the Bahamas, where aggressive enforcement of “no fishing” regulations at the Exuma Cays Land and Sea Park dramatically reduced the frequency and extent of fishing within the MPA (Mascia 2000).

Enforcement systems also shape compliance indirectly. First, by shaping perceptions of overall compliance rates, enforcement systems affect rates of “contingent compliance,” where individuals base their decision to obey rules upon the (perceived) rate of compliance by others (e.g. Himes 2003). The theory of contingent compliance posits that, because individuals seek to avoid being a “sucker” by obeying the rules while others are not, individuals become increasingly likely to obey the rules as the perceived rate of overall compliance increases (Levi 1997). Second, through both the design of sanction mechanisms and the perceived “fairness” of enforcers, enforcement systems shape perceptions of legitimacy. As the perceived legitimacy of MPA enforcement increases, compliance rates also appear to increase (Mascia 2000). Research suggests that meaningful but graduated and context-dependent sanctions, which ensure that punishment fits the crime, are generally perceived as more legitimate than draconian, one-size-fits-all penalties (Ostrom 1990).

Research on the role of monitoring and enforcement systems in MPA performance highlights the importance of accountability, legitimacy, equity, and flexibility. Monitors who actively assess resource conditions and are accountable to resource users (or who are themselves resource users) tend to improve the performance of MPAs and analogous resource governance regimes (Buhat 1994; Ostrom 1990; Woodley and Sary 2003). Likewise, reserve performance is enhanced by the presence of active and accountable monitors of resource use behaviour (Mascia 2000; Roberts 2000; Woodley and Sary 2003). Again, monitors may themselves be resource users. Sanctions for non-compliance must not only be likely and severe enough to raise the cost of non-compliance but also graduated and context-dependent to ensure that punishment fits the crime (Ostrom 1990; Mascia 2000).

5.4 Conflict resolution mechanisms

Conflict resolution mechanisms are formal and informal processes for resolving disputes. Conflict resolution mechanisms permit information exchange, clarification of resource use rights, and adjudication of disputes related to decision making, resource use, monitoring, and enforcement. Critical questions in the design of conflict resolution mechanisms include *Who may participate?* and *Who adjudicates?* Other important design issues include the frequency and location of conflict resolution activities. Readily accessible and low-cost conflict resolution mechanisms enhance regime performance directly by mitigating social conflict and thereby minimizing resource overexploitation and dissipation of MPA benefits (Ostrom 1990). Conflict resolution mechanisms also enhance MPA performance by giving voice to aggrieved parties and acknowledging their concerns, which increases the legitimacy of MPA rules and regulations.

The role of conflict resolution mechanisms in MPA performance is not yet clear. Available data suggest that low cost, local, and readily accessible conflict resolution mechanisms tend to enhance the performance of MPAs and analogous natural resource governance regimes (Ostrom 1990; Mascia 2000). Additional research is clearly needed to understand better the role of conflict resolution mechanisms in reserve performance.

6. MPA SUCCESS FACTORS – EXPERIENCE FROM THE PHILIPPINES

Traditional comparative, statistical analyses of variables influencing success of community-based MPAs involve bivariate correlations and regression analyses (e.g. Pollnac *et al.* 2001; Crawford *et al.* 2006), selecting the variables and/or combinations of variables that are significantly correlated with the measure of success. Variables manifesting significant relationships are often referred to as "predictor variables" to be used in designing future projects.

Although these types of analyses are important and interesting, they do not indicate preconditions for the predictor variables or clearly illustrate the complexity of their interrelationships, which may be essential for the proper structuring of project activities. For example, among the many variables linked to MPA success in the literature, we often hear that peoples' participation is an important factor. But the important question is, exactly how is it related to success? Is it directly influencing success, or does it influence success through its impact on another variable with more direct influence? An understanding of the ordering of these complex links, especially given the tens of variables allegedly related to MPA success may assist project planners in their task of structuring necessary activities.

Usually project planners make decisions concerning implementation activities by using a model based on training and past experience. This type of model is known as a heuristic model. Sometimes this model works and sometime it does not. Variance in success suggests the need to adjust these personal heuristic models, but as noted previously, traditional statistical analyses are not adequate for the task. One way to transcend this inadequacy, however, is to develop a model of factors influencing success of community-based MPAs by using a correlation matrix to identify linkages between the independent variables. The most efficient way to do this is to first identify variables that are most strongly related to the dependent variable, then trace their interrelationships throughout the intercorrelations of all the

independent variables. The following example is derived from a re-analysis of data first presented in Pollnac *et al.* (2001).

6.1 Methods

6.1.1 Dependent and independent variables – MPA success

Previous analyses of this community-based MPA data evaluated success using a summary measure that included differences in coral health (inside and outside the MPA), fishers perceptions of resource changes, compliance with MPA rules, MPA features (e.g. marking buoys, guard house, monitoring program, etc.) and empowerment of villagers with respect to the MPA (Pollnac *et al* 2001). The current example uses only a biological measure of success. This measure is composed of observed differences inside and outside the MPA with regard to coral health (mortality index), numbers of fish families observed, and numbers of top predators (large groupers) observed. Data concerning these indicators were obtained using a systematic snorkel method.[8] Differences for each of the three indicators inside and outside the MPA were calculated, standardized and summed to create the biological measure of community-based MPA success.

6.1.2 Independent (predictor) variables

Previous research involving meetings with focus groups composed of MPA practitioners in the Philippines (Crawford *et al.* 2000) and literature reviews (Crawford *et al*. 2000; Pollnac 2000) identified a number of variables purported to be important for implementation of successful MPAs. The list of independent variables can be found in the analysis section, and details concerning their measurement and justification are in Pollnac *et al.* (2001).

6.1.3 Sample

The analysis is conducted within one nation as a means of controlling for aspects of national legislation and policies that could impact establishment and sustainability of community-based MPAs. A cross-national study would only further complicate an already complicated analytical problem. The Philippines was selected since the nation has had more experience and a larger number of community-based MPAs than any other country. The community-based MPAs in the Philippines also manifest a wide range of levels of success, ranging from "paper" (existing only in legislation) and non-functional community-based MPAs to those that have achieved world-wide recognition for their achievements (e.g. Apo Island).

The sample is a quota sample[9] including only community-based MPAs that include coral reef area, allow no fishing within the boundary, and were officially recognized by municipal ordinance for at least three years. Three years seems to be a sufficient time interval to reduce the impact of the novelty of a new project and the impact of external attention. The sample was selected to include sites manifesting a range of "success", with a stress on geographic representativeness across the four

[8] The systematic snorkel method used required the observer to swim (using a dive mask, snorkel, and fins) over a shallow reef area (1-5 meters deep). The observer had to swim along an imaginary transect line 500 to 1000 meters in total length. The depth of the transect line was maintained by following the contour of the reef. The observer visualized a square meter area on the substrate and, based on a list of parameters, noted the percent cover of each parameter within the imaginary square as seen from the surface. The squares were required to be 50 meters apart (approximated by a predetermined number of fin kicks); hence, ten to twenty 50 meter interval observations were accomplished. This was done both inside and outside (adjacent to) the MPA.

[9] Ideally, it would have been best to use a stratified random sample. We started out with this as our goal, but it soon became apparent that the information we had concerning the "universe" of community-based MPAs in the Visayas was faulty. In most cases we used locally available transportation (buses, jeepnies, tricycles, and motorcycles); hence, travel took up a significant proportion of our time. It was thus difficult to ignore MPAs that fit our sampling criteria if they appeared where we did not expect to find them, especially when many we expected to match our criteria, based on available information, did not.

provinces. The final sample is composed of 14 community-based MPAs located in Bohol, 12 in Leyte, 8 in Cebu and 11 in Negros Oriental (see Figure 2).

6.2 Analysis

The goal is to identify variables that can be used to predict successful community-based MPAs rather than a point estimate on the success indicator; hence, sites were first dichotomized into two groups—very successful and not very successful—with the dividing line one-half standard deviation above the mean on the biological success indicator. In the next step, correlations between the independent variables and the dichotomous biological success measure are calculated (Tables 1 through 3). The results indicate that 15 of the independent variables are statistically significantly correlated with community-based MPA success ($p<0.05$). While the results are interesting, our goal is to identify the structure of the interrelationships between the variables to construct a heuristic model of the factors influencing MPA success. This type of analysis may also indicate why so many variables, expected to be related to MPA success, were not.

6.3 Constructing the model

As noted previously, one way to construct a model is by using the correlation matrix to identify linkages between the independent variables. The most efficient way to do this is to first identify variables that are most strongly related to the dependent variable, then trace their interrelationships throughout the intercorrelations of all the independent variables. There are 83 independent and one dependent variable, resulting in a total of 84 variables. The correlation matrix for 84 variables (to the left of the diagonal ones) includes 3,486 unique correlation coefficients. The matrix will not be presented in this document because it is too large.

Starting with independent variables manifesting correlations of 0.45 or greater (Tables 1 through 3) with the dependent variable (more than approximately 20 percent of the variance), we find the interrelationships identified in Figure 3. The model in Figure 3 indicates that, based on our selection criteria, percent successful alternative income projects, MPA resource monitoring carried out by community members, and adaptive management are the proximate variables influencing MPA success. Arrows are used in the models to suggest a possible causal linkage. Where there are no arrows, it is difficult to suggest a causal relationship. Since the models are developed post analysis, the reader may wish to treat them as informed hypotheses, which should be tested with further research. In Figure 3 the arrows suggest that successful alternative income projects give the incentive and time for project participants to become involved in monitoring the resources within the MPA. Alternative income may also reduce perceived need to fish in the MPA, influencing its success. In turn, the improved resources in the MPA probably provide additional stimulus to remain involved in the monitoring program. The double-headed arrow represents these latter two relationships. Finally, a management system which adapts to phenomena observed during monitoring is more likely to be successful than one which is inflexible.

Figure 4 depicts the independent variables closely related to monitoring by community. We already discussed the relationship between this variable and successful alternative income. Small island is the only variable which meets the criteria in terms of size of correlation, but working into the matrix from small island, we find that community heterogeneity is strongly negatively correlated, so it is also entered into the model. It should be further noted that when a variable meets the criteria and is entered into the model, its relationship with other variables in the model are examined, and if they are statistically significant ($p>0.05$) arrows are drawn to illustrate the relationships. Examples of this are the arrows between MPA performance and the two independent variables village heterogeneity and small islands. The small islands in the sample were the small islands off shore the larger named islands in Figure 2. Relatively small populations where inhabitants know each other and are in almost constant face-to-face interaction carrying out similar activities characterize these islands. People sharing similar backgrounds and in face-to-face interaction are probably more likely to cooperate in a joint venture like a community based MPA; hence the negative correlation with heterogeneity.

Following the same model building criteria working out from adaptive management we find the relationships depicted in Figure 5. Monitoring conducted by advisors has the strongest relationship with adaptive management in Figure 5. In turn adaptive management and monitoring by advisors has a relatively strong impact on number of ongoing trainings. This is probably due to the fact that the monitoring reveals areas where community members could benefit from further training. These ongoing trainings are relatively strongly related to the MPA features score. This makes sense since the training would facilitate maintenance of activities and features that compose the MPA features score. Ongoing trainings are also strongly related to community empowerment concerning the MPA. The knowledge imparted by the ongoing training informs villagers concerning the significance of their activities (e.g. surveillance of the MPA, maintenance of MPA boundary markers, not fishing in the MPA, etc.) with regard to resource protection. This is reflected in the very strong relationship between community empowerment and compliance. Empowerment may also result in the community asking for more training, hence the double-headed arrow between the two variables. Monitoring of MPA features by the advisors also influences changes that are reflected in the two-way interrelationship between adaptive management and the MPA features score.

Finally we use the same criteria to extend our model out through successful alternative occupations. Figure 6 indicates that a fairly large number of variables are related to percent successful alternative income projects. Perhaps the most important is formation of a core group of community members early on in the implementation process. Early community involvement in all types of development projects, including MPAs, has frequently been cited as a factor that influences success (see Rogers 1995; White *et al.* 1994; Morss 1972). The strong relationship this variable has with other variables related to the alternative income variable (e.g. community participation scale, number of initial trainings, MPA features score, and compliance) illustrates the importance of early involvement of a core group of community members. It is probably safe to assume that this group is both logically and temporally prior to and manifesting no feedback from the other variables with which it is connected by an arrow. Arrows connecting MPA success with compliance and MPA features are included although the correlations are below 0.45 since these variables are probably influenced by alternative income and are intermediary between alternative income and MPA success. Participation and initial trainings probably have a direct impact on successful alternative income projects, and the alternative income, in turn, facilitates compliance and the MPA features. For example, villagers will be less likely to violate the MPA due to need if some needs are fulfilled by the alternative income, as well as more likely to support aspects of the MPA features scale. The positive feedback from MPA success will also impact compliance and support of MPA features.

6.4 Conclusions

The model developed here is unquestionably superior to traditional analyses which indicate only direct relationships with the success of MPAs. For example, the model clearly indicates the dynamics of the interrelationships between the so-called “predictor” variables. For example, the model makes it obvious that successful alternative incomes are the result of first, early core group formation, which influences both number of initial trainings and participation, both of which influence introduction of successful alternative livelihoods. The model indicates that early formation of the core group has multiple statistically significant relationships with variables that both directly and indirectly impact MPA performance, yet the bivariate correlation presented in Table 3 (0.30, $p>0.05$) is not statistically significant. The important position of this variable alone in our heuristic model justifies the claim that the modelling process can lead to findings that are of significance in project design. In conclusion, we contend that application of the findings of this section of the report can significantly increase our ability to develop successful and sustainable MPAs.

7. RECOMMENDATIONS – BEST PRACTICES

In some circles, MPAs have come to be advocated as the solution for all fisheries and ecosystem management problems. In reality, MPAs are not substitutes for fishery management, but are one of

several tools in the toolbox. This paper has identified a number of social dimensions of MPA design, implementation, and performance that should be considered in the best practices in the use of MPAs.

- MPAs are the product of social institutions and are established to change human behaviour by restructuring the incentives that people face in their use of coastal and marine resources.
- Goals for the scope and purpose of MPAs must reflect a balance between scientific and social and economic needs and realities.
- MPA design and implementation should seek to understand the diversity of coastal people and communities, especially in relation to their livelihood strategies.
- MPA design and implementation requires understanding the means by which households adapt to reduce their risks, the incentives that drive the decisions of resource users, and the sources of vulnerability to stresses and shocks.
- Communication about the purpose and intent of the MPA must be clear and transparent and presented early in the process so that any misperceptions can be addressed.
- People, individually and as a group, should be made to feel that they have been part of the decision-making process of the MPA, and have been able to actively participate in and influence the process. Without this, it will be difficult to obtain support and compliance.
- Perceptions and attitudes towards MPAs will be shaped by cultural traditions and values.
- Individuals must feel that the benefits to be obtained from participation in the MPA, including compliance with rules, will be greater than the costs of such activities.
- Combining resource management with livelihood opportunities that provide economic benefits in the short-run are useful to address any economic disruptions to the individual or household.
- A socioeconomic assessment can be used to learn about the social, cultural, economic and institutional context and conditions of individuals, groups and communities, and identify the potential impacts of the MPA.
- The benefits and costs of MPAs will potentially affect the individual fisher, the fisher's household, and the fishing community.
- The magnitude of the benefits and costs will be affected by the MPAs objectives, size, location, allowed uses, and level of compliance.
- A potential cost to the fisher is that catch, and revenues, may be decreased, at least in the short-term, as a result of the implementation of the closure. The coastal community adjacent to the MPA, especially those with a high economic dependency upon the fishery, may face a disproportionate impact, particularly in the short-term, as a result of aggregate reduction in fishing revenue. Efforts should be made to minimize disruptions to lives and livelihoods through impact assessment and preparing strategies to address the disruptions.
- Strategies need to be put in place to address increased occupational risks to the fishers due to shifts in fishing grounds and travel time as a result of the MPA.
- MPAs can reduce potential conflicts between fishers and other users by providing areas where non-fishery users can pursue non-consumptive uses of the resources.
- Excessive visitation of MPAs, and the development that can accompany tourism, can be damaging to the environment and reduce the biological, cultural and economic benefits obtained from the closure. It is important to monitor and manage MPAs to ensure that sustainable levels of tourism are not exceeded.
- Alternative or supplementary livelihood opportunities may not be available for all fishers and their families as a result of economic base shifts in the community, increasing hardships to many. Some community members may be negatively impacted as a result of economic changes in the community, such as tourism, and the loss of their traditional way of life.

- Share responsibility and authority by bringing diverse stakeholder groups, including resource users, into MPA decision-making and management processes improves the substance and legitimacy of these decisions, increases management capacity, and enhances the legitimacy of management activities.
- Accountability mechanisms (e.g. elections, consultative sessions, or open meetings) increase the likelihood that decision makers will further constituents' interests rather than personal interests in decision-making processes. Accountability mechanisms also foster fair and active enforcement of rules governing resources use by enforcement personnel.
- Resource user self-governance initiatives that are consistent with reserve policy objectives can serve as effective complements to other management efforts.
- Clear MPA boundaries and clear rules governing resource use within reserves foster compliance and simplify enforcement.
- Linking reserve rules to the state of social and environmental systems fosters adaptive (and more socially and environmentally sustainable) management of these systems.
- Reserve rules that allocate resource use benefits to users in rough proportion to the costs that these users incur to provide the same MPA resources will likely be perceived as more legitimate, and thus enjoy greater compliance, than rules that allocate benefits disproportionate to their costs.
- Building MPAs on the foundation of existing systems of informal or customary resource use rights enhances reserve legitimacy and fosters compliance among resource users.
- Tracking the environmental and social dimensions of MPA performance provides the basis for adaptive management.
- Enlisting stakeholders, including resource users, in data collection and analysis educates participants, builds capacity, and fosters trust.
- Sharing information regarding the environmental and social performance of MPAs may enhance reserve legitimacy or provide the impetus for necessary policy reform.
- Graduated, context-dependent sanctions enhance compliance by raising the opportunity cost of non-compliance and enhancing the perceived legitimacy of the reserve.
- Broad dissemination of information regarding compliance rates and enforcement actions can enhance reserve legitimacy and foster contingent compliance.
- Highly accessible conflict resolution mechanisms provide a vehicle for resolving disputes that would otherwise increase costs of resource use and, thus, diminish reserve benefits.

REFERENCES

Acheson, J. 2003. *Capturing the Commons: Devising Institutions to Manage the Maine Lobster Industry.* Hanover, NH: University Press of New England.

Allison, E.H. & Ellis, F. 2001. The livelihoods approach and management of small-scale fisheries. *Marine Policy*, 25:377-388.

Bailey, C. & Pomeroy, C. 1996. Resource dependency and development options in coastal Southeast Asia. *Society and Natural Resources*, 9: 191-199.

Berkes, F.; Colding, J. & Folke, C. 2000. Rediscovery of traditional ecological knowledge as adaptive management. *Ecological Applications,* 10: 1251-1262.

Berkes, F.; Mahon, R.; McConney, P.; Pollnac, R. & Pomeroy, R. 2001. *Managing small-scale fisheries: alternative directions and methods.* International Development Research Centre, Ottawa, Canada.

Bohnsack, J.A. 1993. Marine reserves: they enhance fisheries, reduce conflicts, and protect resources. *Oceanus,* 36:33, 63-71.

Brewer, G.D. & deLeon, P. 1983. *The Foundations of Policy Analysis*. Dorsey Press, Homewood, Illinois.

Bromley, D.W. 1991. *Environment and economy: property rights and public policy*. Blackwell, Cambridge, MA, USA.

Buhat, D. 1994. Community-based coral reef and fisheries management, San Salvador, Island, Philippines. *In* White, A. T., L. Z. Hale, Y. Renard, & L. Cortesi (eds.), *Collaborative and Community-Based Management of Coral Reefs: Lessons from Experience.* pp 33–50. West Hartford, CT: Kumarian.

Bunce, L.; Townsley, P.; Pomeroy, R. & Pollnac, R. 2000. *Socioeconomic Manual for Coral Reef Management.* Townsville: Australian Institute of Marine Science.

Caribbean Natural Resources Institute (CANARI). 2005. Marine protected areas and sustainable coastal livelihoods. *CANARI Policy Brief No. 5*. Caribbean Natural Resources Institute, Trinidad and Tobago. 4pp.

Charles, A. 2001. *Sustainable fishery systems*. Blackwell Science. Oxford, United Kingdom.

Christie, P. & White, A.T. 1997. Trends in development of coastal area management in tropical countries: From central to community orientation. *Coastal Management,* 25:155–181.

Christie, P.; McCay, B.J.; Miller, M.L.; Lowe, C.; White, A.T.; Stoffle, R.; Fluharty, D.L.; McManus, L.T.; Chuenpagdee, R.; Pomeroy, C.; Suman, D.O. ; Blount, B.G.; Huppert, D.; Eisma, R.-L.V.; Oracion, E.; Lowry, K. & Pollnac, R.B. 2003. Toward Developing a Complete Understanding: A Social Science Research Agenda for Marine Protected Areas. *Fisheries,* 28: 22-26.

Costanza, R.; Andrade, F. & Antunes, P. 1998. Principles of sustainable governance of the oceans. *Science*, 281: 198-199.

Crawford, B.; Balgos, M. & Pagdilao, C.R. 2000. Community-based marine sanctuaries in the Philippines: a report on focus group discussions. Coastal Resources Center, University of Rhode Island, Kingston, Rhode Island. 85pp.

Crawford, B.R.; Kasmidi, M.; Corompis, F. & Pollnac, R.B. 2006. Factors influencing progress in establishing community-based marine protected areas in Indonesia. *Coastal Management*, 34: 39-64.

Dalton, T.M. 2005. Beyond biogeography: a framework for involving the public in planning of US marine protected areas. *Conservation Biology*, 19(5): 1392-1401

Dixon, J.A.; Fallon Scura, L. & van't Hof, T. 1993. Meeting ecological and economic goals: marine parks in the Caribbean. *Ambio,* 22 (2–3):117–125.

Dobrzynski, T. & Nicholson, E.E. 2003. User group perceptions of the short-term impacts of marine reserves in Key West. *In* Kasim Moosa, M. K.; Soemodihardjo, S.; Nontji, A.; A. Soegiarto, K. Romimohtarto, Sukarno, and Suharsono, eds. *Proceedings of the Ninth International Coral Reef Symposium*, pp 759–764. Jakarta: Indonesian Institute of Sciences and State Ministry for Environment, Republic of Indonesia.

Ecosystem Principle Advisory Group. 1999. Report mandated by the Sustainable Fisheries Act amendments to the Magnuson-Stevens Fishery Conservation and Management Act of 1996. National Marine Fisheries Service, NOAA, Silver Spring, MD.

Erdman, M. & Bishop, M. 2003. Summary of results and discussion from ITMEMS2 Theme 12: Enforcement sessions. Second International Tropical Marine Ecosystems Management Symposium. Manila, Philippines.

Farrow, S. 1996. Marine protected areas: Emerging economics. *Marine Policy,* 20 (6):439–446.

Fiske, S.J. 1992. Sociocultural aspects of establishing marine protected areas. *Ocean and Coastal Management,* 18:25–46.

Garcia, S. & Newton, C. 1994. *Current situation, trends and prospects in world capture fisheries*. Paper presented at the Conference on Fisheries Management: Global Trends, June. Seattle, Washington, USA.

Gislason, H.; Sinclair, M.; Sainsbury, K. & O'Boyle, R. 2000. Symposium overview: incorporating ecosystem objectives within fisheries management. *ICES Journal of Marine Science*, 57(3):468-475.

Goodridge, R.; Oxenford, H.A.; Hatcher, B.G. & Narcisse, F. 1996. Changes in the shallow reef fishery associated with implementation of a system of fishing priority and marine reserve areas in Soufriere, St. Lucia. In *Proceedings of the 49th Gulf and Caribbean Fisheries Institute, Bridgetown, Barbados, November, 1996.* Ft. Pierce, FL: Gulf and Caribbean Fisheries Institute.

Halpern, B. 2003. The impact of marine reserves: do reserves work and does reserve size matter? *Ecological Applications*, 13(1): S117-S137.

Hanna, S. 2004. The economics of protected areas in marine fisheries management: an overview of issues. *In* J.B. Shipley (Ed.) *Aquatic protected areas as fisheries management tools*. American Fisheries Society Symposium 42, American Fisheries Society, Bethesda, MD. pp. 259-265.

Healy, R.G. & Ascher, W. 1995. Knowledge in the Policy Process: Incorporating New Environmental Knowledge in Natural Resources Policy Making. *Policy Studies,* 28: 1-19.

Heyman, W.D & Graham, R.T. 2001. Whale sharks (Rhincodon typus) aggregate to feed on fish spawn in Belize. *Marine Ecology-Progress Series,* 215: 275-282.

Himes, A.H. 2003. Small-scale Sicilian fisheries: opinions of artisanal fishers and sociocultural effects in two MPA case studies. *Coastal Management*, 31: 389-408.

Hoagland, P.; Yashiaki, K. & Broadus, J.M. 1995. A methodology review of net benefit evaluation for marine reserves. *Environmental Economics Series* No. 27. World Bank, Washington, DC.

Hoffman, T.C. 2002. The reimplementation of the Ra'ui: coral reef management in Rarotaonga, Cook Islands. *Coastal Management,* 30: 401-418.

IUCN - The World Conservation Union. 1988. Resolution 17.38 of the 17th General Assembly of the IUCN. Gland, Switzerland and Cambridge, UK: IUCN.

Johannes, R.E. 1978. Traditional marine conservation methods in Oceania and their demise. *Annual Review of Ecology and Systematics,* 9: 349–364.

Johannes, R.E. 2002. The renaissance of community-based marine resource management in Oceania. *Annual Review of Ecology and Systematic,* 9: 349-364.

Kelleher, G. & Recchia, C. 1998. Lessons from marine protected areas around the world. *Parks,* 8(2): 1–4.

Kempton, W.; Boster, J.S. & Hartley, J.A. 1995. *Environmental Values in American Culture.* Boston: MIT Press.

Levi, M. 1997. *Consent, Dissent, and Patriotism.* Cambridge: Cambridge University Press.

Mascia, M.B. 2000. *Institutional Emergence, Evolution, and Performance in Complex Common Pool Resource Systems: Marine Protected Areas in the Wider Caribbean*. Department of the Environment, Duke University, Durham, NC. (Ph.D. diss.)

Mascia, M.B. 2001. Designing Effective Coral Reef Marine Protected Areas: A Synthesis Report Based on Presentations at the 9th International Coral Reef Symposium. IUCN World Commission on Protected Areas-Marine, Washington, D.C.

Mascia, M.B. 2003. The Human Dimension of Coral Reef Marine Protected Areas: Recent Social Science Research and Its Policy Implications. *Conservation Biology* 17(2) 630-632.

Mascia, M.B. 2004. Social Dimensions of Marine Reserves. Pages 164-186. *In:* C. Dahlgren, and J. Sobel, (editors). *Marine Reserves: A Guide to Science, Design, and Use*. Island Press, Washington, DC.

Mascia, M.B.; Fox, H.E. & Lombana, A. *in prep.* Solving the Mystery of Marine Protected Area (MPA) Performance: Linking Governance, Biodiversity Conservation, and Poverty Alleviation. For submission to *Marine Policy.*

McClanahan, T.R. 1999. Is there a future for coral reef parks in poor tropical countries? *Coral Reefs,* 18: 321–325.

McClanahan, T.R. & Glaesel, H. 1997. The effects of traditional fisheries management on fisheries yields and the coral reef ecosystems of Southern Kenya. *Environmental Conservation*, 24(2): 105-120.

McClanahan, T.R. & Kaunda-Arara, B. 1996. Fishery recovery in a coral-reef marine park and its effect on the adjacent fishery. *Conservation Biology,* 10(4): 1187–1199.

McClanahan, T.R. & Mangi, S. 2000. Spillover of exploitable fishes from a marine park and its effect on the adjacent fishery. *Ecological Applications,* 10(6):1792–1805.

Morss, E.R. 1976. *Strategies for Small Farmer Development* (2 Vol.). Boulder, CO: Westview Press.

National Marine Fisheries Service. 1999. Ecosystem-based fisheries management. Ecosystem Advisory Panel to NMFS. NOAA Technical Memorandum NMFS-F/SPO-23. National Marine Fisheries Service, Silver Spring, MD.

National Research Council (NRC). 1999. *Sustaining marine fisheries*. National Academy Press. Washington, DC.

National Research Council (NRC). 2001. *Marine protected areas: tools for sustaining ocean ecosystems*. National Academy Press, Washington DC.

National Oceanic and Atmospheric Administration-National Marine Protected Areas Center (NOAA-NMPAC). 2005. Social Science Research Strategy for Marine Protected Areas. MPA Science Institute, Santa Cruz, CA.

Obura, D.O.; Wells, S.; Church, J. & Horrill, C. 2002. Monitoring of fish and fish catches by local fishermen in Kenya and Tanzania. *Marine and Freshwater Research,* 53: 215-222.

Ostrom, E. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action.* Cambridge: Cambridge University Press.

Pezzey, J.C.V.; Roberts, C.M. & Urdal, B.T. 2000. A simple bioeconomic model of a marine reserve. *Ecological Economics,* 33: 77–91.

Pollnac, R.B.; Crawford, B.R. & Gorospe, M.L.G. 2001. Discovering factors that influence the success of community-based marine protected areas in the Visayas, Philippines. *Ocean and Coastal Management,* 44: 683–710.

Pomeroy, R.S. 1991. Small-Scale Fisheries Management and Development: Towards a Community-Based Approach. *Marine Policy,* 15 (1): 39-48.

Pomeroy, R.S. 1994. Common Property Regimes. *NAGA, The ICLARM Quarterly.* 17(2): 37-38.

Pomeroy, R.S. & Rivera-Guieb, R. 2006. *Fishery co-management: a practical handbook*. CABI Publishing, Cambridge, MA. USA and International Development Research Centre, Ottawa, Canada.

Pomeroy, R.S.; Katon, B.M. & Harkes, I. 2001. Conditions affecting the success of fisheries co-management: lessons from Asia. *Marine Policy*, 25: 197-208.

Pomeroy, R.S.; Parks, J.E. & Watson, L.M. 2003. *How is Your MPA Doing? A Guidebook: Biophysical, socioeconomic and governance indicators for the evaluation of management effectiveness of marine protected areas.* IUCN World Commission on Protected Areas-Marine, World Wide Fund for Nature, and National Oceanographic and Atmospheric Administration. Gland, Switzerland and Silver Spring, Maryland.

Pomeroy, R.S.; Oracion, E.G.; Pollnac, R.B. & Caballes, D.A. 2005. Perceived economic factors influencing the sustainability of integrated coastal management projects in the Philippines. *Ocean and Coastal Management*, 48: 360-377.

Pomeroy, R.; Ratner, B.; Hall, S.; Pimoljinda, J. & Vivekanandan, V. 2006. *Rehabilitating livelihoods in tsunami-affected coastal communities in Asia*. World Fish Center, Penang, Malaysia.

Rettig, B. 1994. Who should preserve the marine environment? *Marine Resource Economics*, 9: 87-94.

Roberts, C.M. 2000. Selecting marine reserve locations: Optimality versus opportunism. *Bulletin of Marine Science,* 66(3): 581–592.

Roberts, C.M. & Hawkins, J.P. 2000. *Fully-protected marine reserves: a guide*. WWF Endangered Seas Campaign, Washington DC and Environment Department, University of York, York, United Kingdom.

Roberts, C.M. & Polunin, N.V.C. 1993. Marine reserves: simple solutions to managing complex fisheries? *Ambio*, 22: 363-368.

Roberts, C.M.; Bohnsack, J.A.; Gell, F.; Hawkins, J.P. & Goodridge, R. 2001. Effects of marine reserves on adjacent fisheries. *Science,* 294: 1920–1923.

Rogers, E.M. 1995. *Diffusion of Innovations* (4th Edition). New York: The Free Press.

Ruddle, K. 1996. Traditional management of reef fishing. In: N.V. Polunin and C.M. Roberts (Eds.) *Reef Fisheries*. Chapman and Hall, New York.

Sanchirico, J.N.; Cochran, K.A. & Emerson, P.M. 2002. Marine protected areas: economic and social implications. Discussion Paper 02-26. Resources for the Future, Washington DC.

Sissenwine, M.P. & Mace, P.M. 2001. Governance for Responsible Fisheries: An Ecosystem Approach. Paper presented at the Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem, Reykjavik, Iceland, 1-4 October 2001. 29 p.

Smith, L.E.D.; Nguyen Khoa, S. & Lorenzen, K. 2005. Livelihood Functions of Inland Fisheries: Policy Implications in Developing Countries. *Water Policy*, 7(4):359-384.

Stern, M.J. In press. Payoffs v. Process: Expanding the paradigm for park/people studies beyond economic rationality. *Journal of Sustainable Forestry*.

Suman, D.; Shivlani, M. & Milon, J.W. 1999. Perception and attitudes regarding marine reserves: A comparison of stakeholder groups in the Florida Keys National Marine Sanctuary. *Ocean and Coastal Management,* 42(12): 1019–1040.

Thomson, C. 1998. Evaluating marine harvest refugia: an economic perspective. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-255. Silver Spring, MD. pp. 78-83.

Vogt, H.P. 1997. The economic benefits of tourism in the marine reserve of Apo Island, Philippines. In: Lessios, H. A. & I. G. Macintyre (eds.) *Proceedings of the 8th International Coral Reef Symposium.* Panama City, Panama: Smithsonian Tropical Research Institute.

White, A.T.; Hale, L.Z.; Renard, Y. & Cortes, **L.** 1994. The need for community based coral reef management. In*:* White, A.T., L.Z. Hale, Y. Renard & L. Cortes (Eds.). *Collaborative and Community Based Management of Coral Reefs*. pp. 1-18. West Hartford, CN: Kumarian Press.

White, A.T.; Salamanca, A. & Courtney, C.A. 2002. Experience with Marine Protected Area Planning and Management in the Philippines. *Coastal Management,* 30: 1-26.

Woodley, J.D. & Sary, Z. 2003. Development of a locally managed fisheries reserve at Discovery Bay, Jamaica. In: Kasim Moosa, M. K., S. Soemodihardjo, A. Nontji, A. Soegiarto, K. Romimohtarto, Sukarno and Suharsono (eds.). *Proceedings of the Ninth International Coral Reef Symposium,* 627–634. Jakarta, Indonesia: Indonesian Institute of Sciences and State Ministry for Environment, Republic of Indonesia.

Zinn, J. & Buck, E.H. 2001. Marine protected areas: an overview. Congressional Research Service Report made available to the public by the National Council for Science and the Environment. Washington DC.

ANNEX 1: TABLES AND FIGURES

Table 1. Correlations between socioeconomic and cultural variables and MPA biological success measure.

Number of occupations in village	-0.10
Number of religions (heterogeneity index)	-0.36*
Percent farmers	0.02
Percent fishers	-0.07
Reef fishery important to village	-0.06
Level of tourism activities	0.35*
General village development	-0.11
Level of advanced village development	-0.04
Level of moderate village development	-0.28
Level of basic village development	-0.09
Percent children underweight	-0.13
Percent children moderate/severe underweight	0.07
Level of village market integration	0.04
Level of village transportation integration	-0.22
Level of village communication integration	-0.29
Level of village political integration	-0.23
Total village integration score	-0.28
Village stability (leader turnover)	-0.20
Peoples' participation in village decisions	0.15
Number of cooperative groups in village	-0.08
Level of intra-village conflict	0.07
Level of municipal development	-0.03
Percent with electricity (municipal)	0.17
Percent with private water faucet (municipal)	0.00
Percent with unsealed toilets (municipal)	-0.23
Percent with no toilet (municipal)	0.03
Percent with no or unsealed toilet (municipal)	-0.15
Density of unsealed or no toilet households	0.30
Municipal stability (mayor turnover)	0.12

*p<0.05 **p<0.01

Table 2. Correlations between environmental and demographic variables and MPA biological success measure.

Village area	-0.30
Distance from municipal center	0.16
Village population (1995)	-0.35*
Municipal population (1995)	0.01
Small island location	0.33*
Village population density (1995)	0.17
Change in village population density (1975-95)	0.11
Perceived pre-MPA crisis in coral	0.16
Perceived pre-MPA crisis in fish stocks	0.26
Amount of trash (garbage, water and beach)	0.16
Amount of debris (natural, water and beach)	0.22
Amount of trash and debris	0.21

*p<0.05 **p<0.01

Table 3. Correlations between project activities and output variables and MPA biological success measure.

MPA public ceremony at implementation	0.43**
Government officials visit MPA	0.30
MPA area	0.21
Distance of MPA from village	-0.03
MPA visible from village	-0.22
Other CRM projects in village	0.31
Non-MPA issues addressed through early action	0.17
Percent successful alternative income projects	0.49**
Village influenced size and location of MPA	-0.01
Village initiated development of MPA	-0.16
Village received external advice for MPA	0.11
Distance of MPA advisors from village	-0.06
MPA advice continued after implementation	0.16
Villagers can go to organization for advice	0.26
Consultations with villagers about MPA	0.16
Formal MPA consultations (formal meetings)	0.14
Informal consultations	0.34*
Frequency of village MPA consultations	0.23
Villagers voted on MPA	0.14
MPA core group formed early in process	0.30
Level of community empowerment concerning MPA	0.39*
MPA project participation component score	0.23
Monitoring causes change--adaptive management	0.46**
MPA monitoring done by villagers	0.49**
MPA monitoring done by advisors	0.06
Village had a live-in expert	-0.07
Villagers visited other MPAs(cross visits)	0.10
Number of initial trainings	0.35*
Number of ongoing trainings	0.38*
MPA project training component score	0.30
Any municipal inputs	0.25
Any village inputs	0.09
Any other inputs	0.07
Total MPA inputs score	0.27
Any community contribution to MPA	0.16
Satisfactory municipal inputs	0.43**
Satisfactory village inputs	-0.01
Satisfactory inputs from other sources	0.16
Community contribution to MPA project	0.23
Level of MPA rule compliance	0.41**
MPA features score	0.38*
Fishers perception of MPA influence on resource	0.29

*p<0.05 **p<0.01

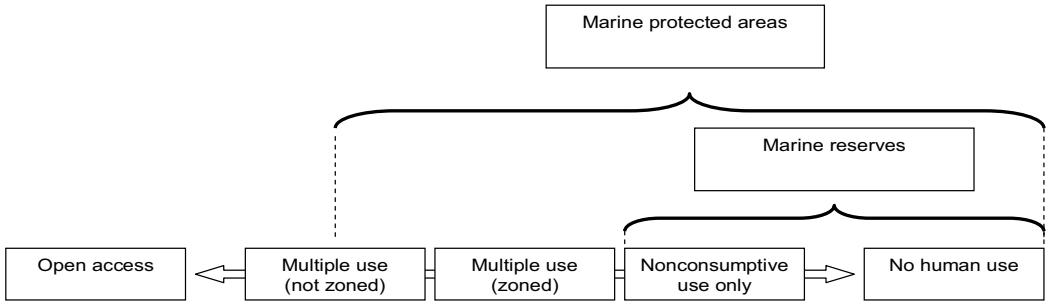

Figure 1. Relationship of MPAs to other forms of marine resource governance. Redrawn from Mascia (2004).

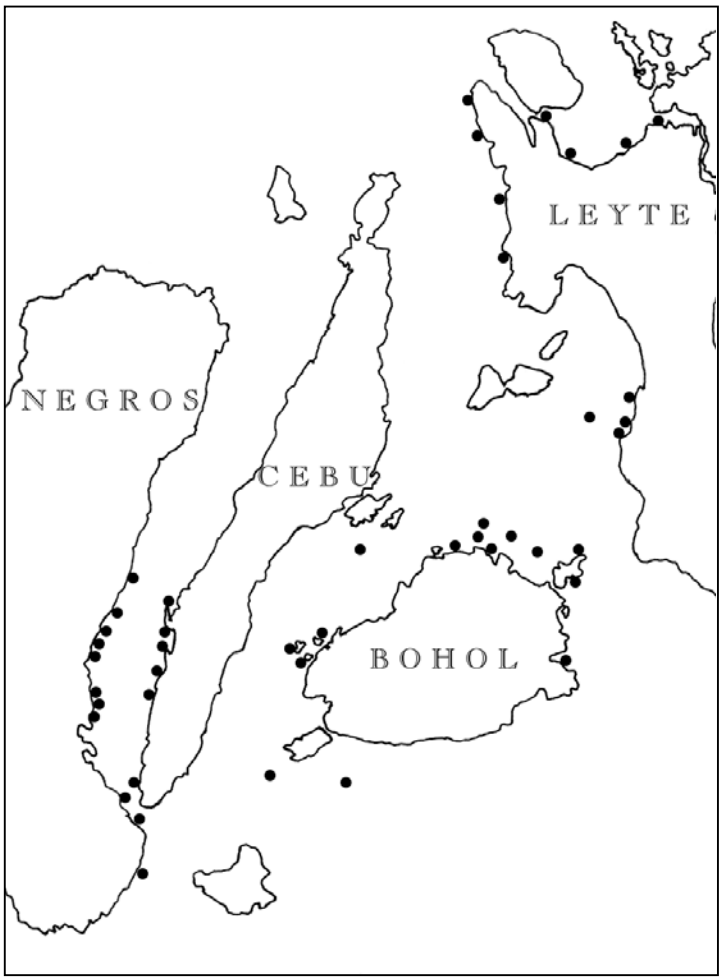

Figure 2. Locations of MPAs in sample.

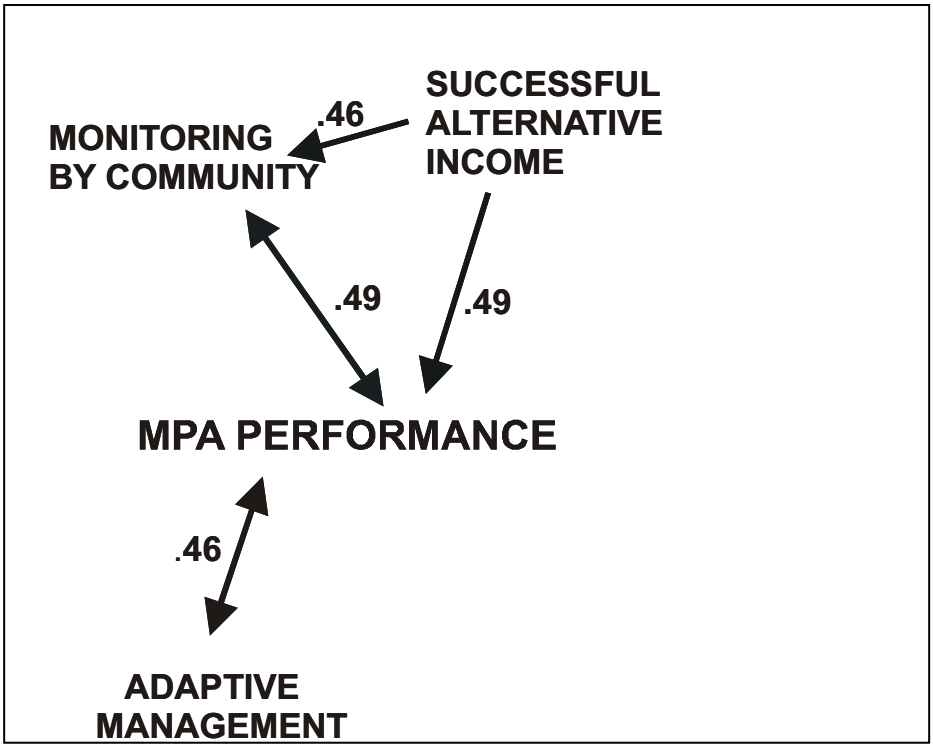

Figure 3. Variables directly related to MPA performance.

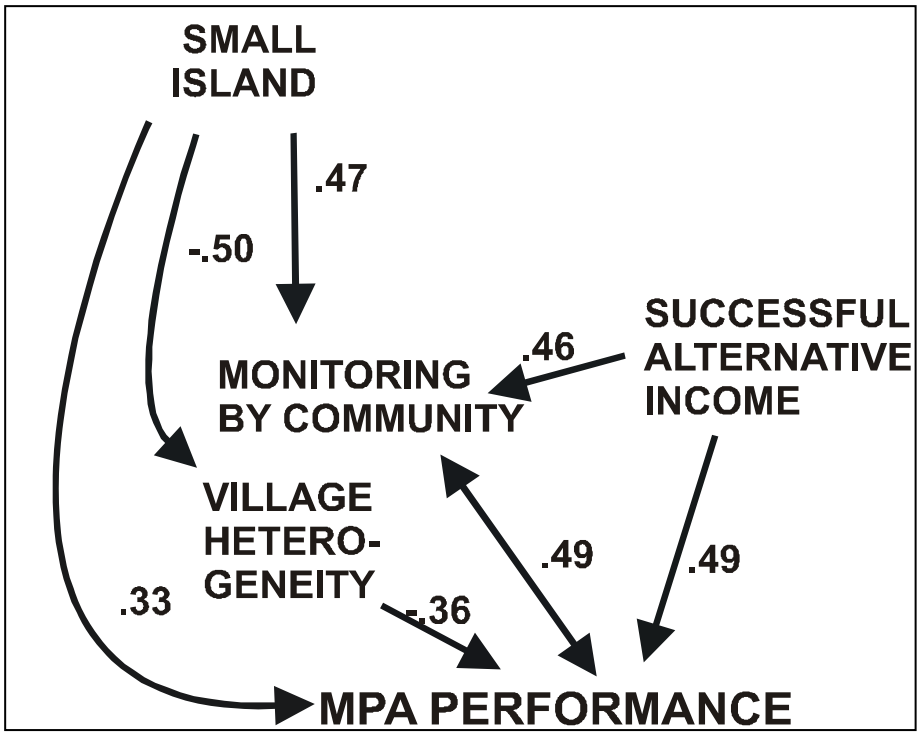

Figure 4. Variables related to MPA performance through monitoring by community.

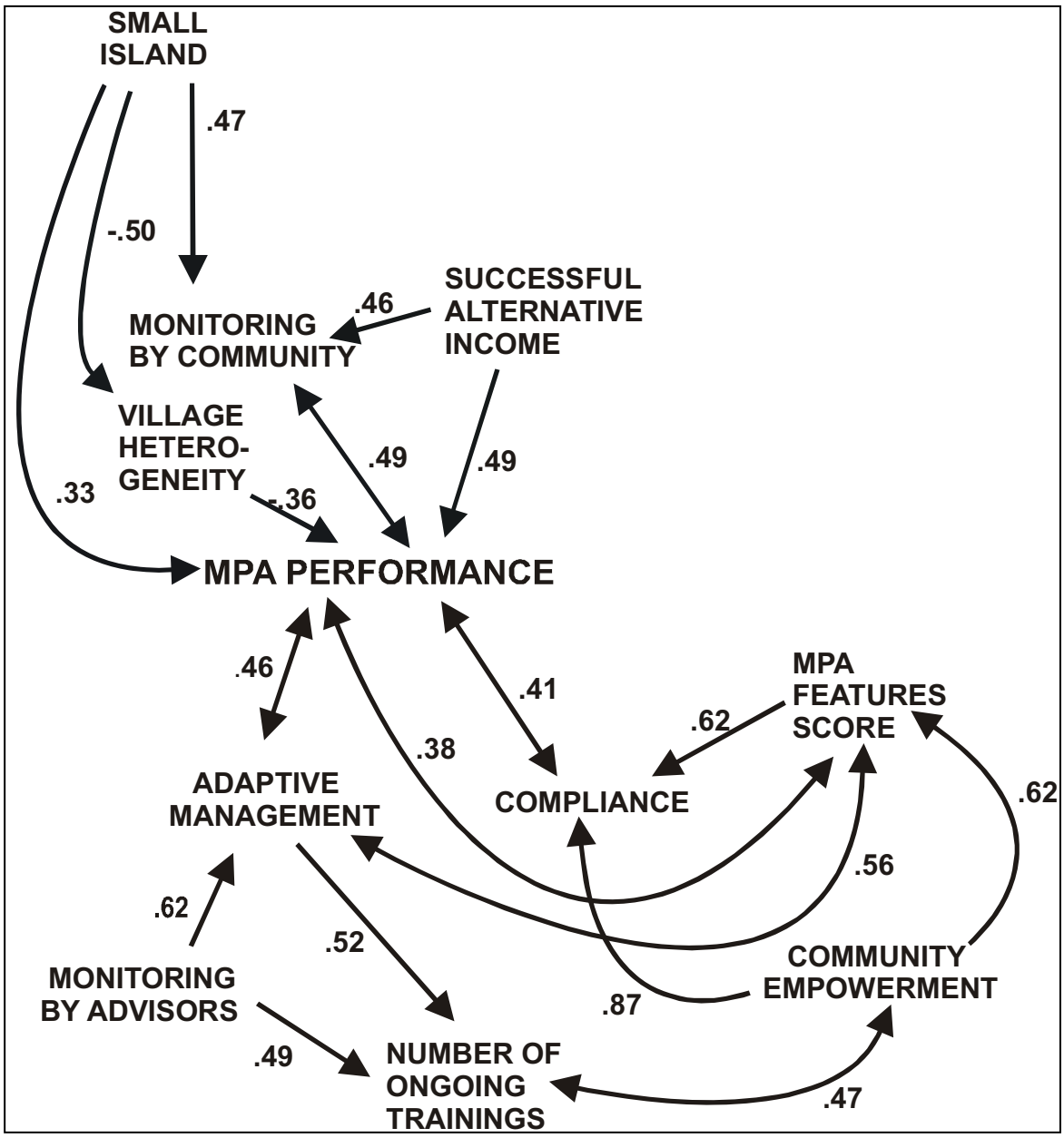

Figure 5. Including variables related to MPA performance through adaptive management.

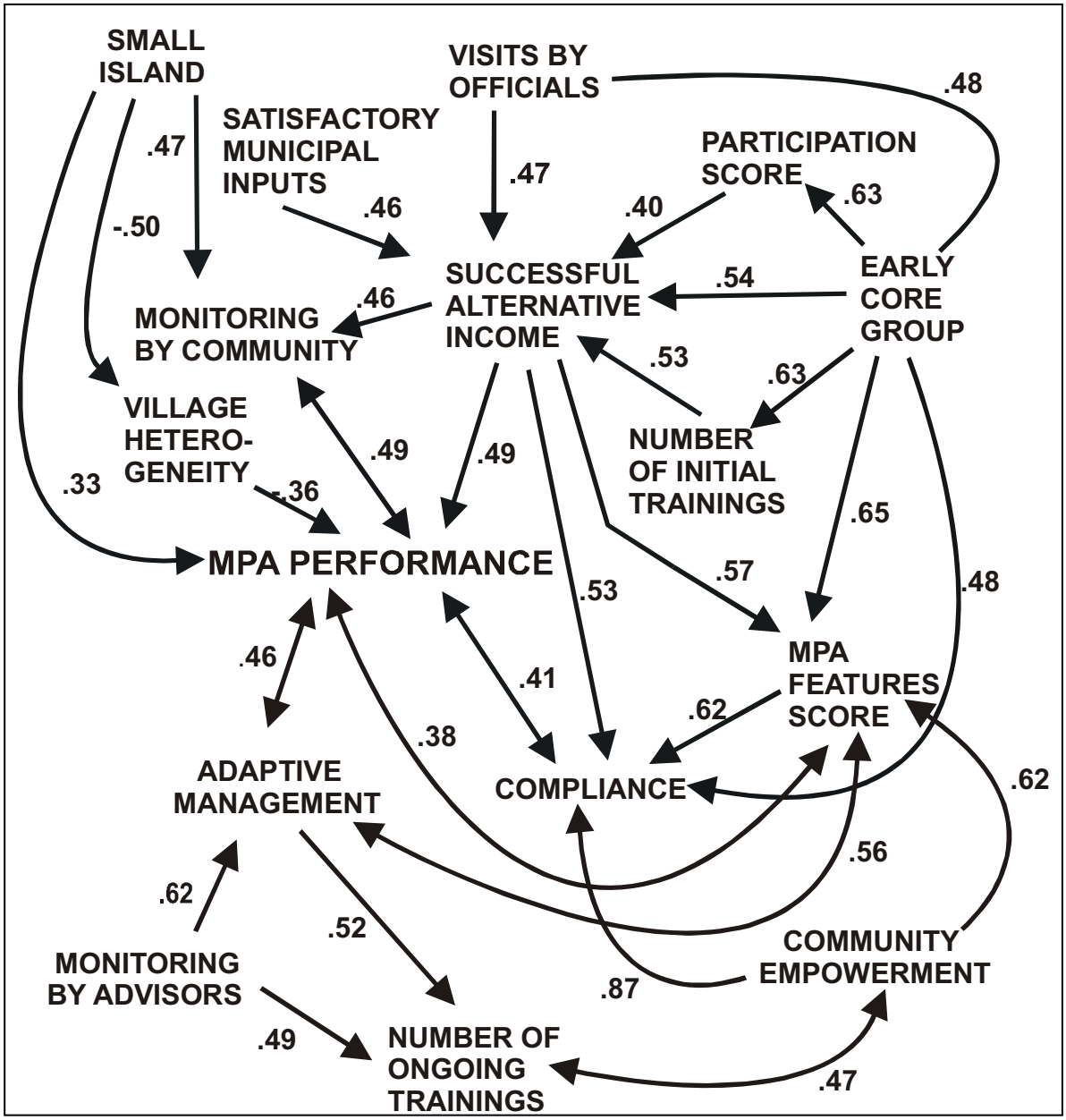

Figure 6. Including variables related to MPA performance through successful alternative income.