Lessons learned and good practices in the management of coral reef Marine Protected Areas

INTRODUCTION

The objective of this project is to formalize the experiences, outcomes and lessons learned from previous GEF projects, as well as major non-GEF initiatives involving marine protected areas (MPAs) in coral reefs and associated ecosystems. The project aims to comprehensively identify, analyze, and translate lessons into good practices and information resources, and then disseminate this information globally for use in future project design and development. Based on its history of supporting coral reef biodiversity, management and sustainable development, this project will help the GEF fulfill a major mandate to identify what has worked and what could be improved upon in supporting biodiversity conservation. In combination with other GEF projects, this effort will also help the GEF and other major non-GEF projects achieve a markedly improved return on investment for future projects involving coral reefs MPAs.

Since the 1990s, over $320 million of GEF funds were invested in projects at varying action and technical levels to improve the management of coral reef, seagrass and mangrove habitats, much of which was part of a broader portfolio of over $600 million invested in coastal-marine projects overall. During four entry periods each year, the GEF receives well over 200 concepts and project proposals annually. Even though the actual number of pipeline-approved projects is much less, the volume and diversity of those projects approved has far exceeded the Secretariat's ability to review and assess those elements that have worked and what could be improved upon.

The dissemination of best practices based on lessons learned is a strategic priority for the GEF. However, in the case of coral reef projects no comprehensive understanding of GEF successes and failures has ever been conducted. In recent reviews of GEF performance and activities, the need to utilize the results of previous project outcomes, experiences and lessons learned more comprehensively has been highlighted. Earlier works exist that extract lessons learned from previous projects, looking at both success and failure and comparing across global regions; however, such work has been neither comprehensive nor systematic.

METHODS

This project initially sought to review all GEF-funded projects related to coral reefs and associated tropical marine ecosystems (65 projects in total) and about 10-20 key non-GEF funded projects. However, review of the GEF projects indicated that only 20 GEF projects had sufficient focus on coral reef MPAs, were either completed or far enough along to have gathered lessons learned information, or had sufficient available documentation. Many of the others were too recent to have gathered useful information, while several had been cancelled due to implementation problems.

In order to gather more useful information, we examined 50 non-GEF funded projects, based on a variety of criteria. Of these, 21 projects had sufficient lessons learned information to warrant including in our analysis. In addition to reviewing project documentation (progress reports, final reports), primary literature was consulted where these publications arose directly from the projects reviewed. In addition, personal interviews of project personnel were conducted. From our review of coral reef MPAs, we identified best practices in four broad areas of MPA management:

1. Ecological objectives and impacts;
2. Socio-cultural objectives and impacts;
3. Economic objectives and impacts;
4. Governance issues.

ISSUE 1: Ecological Objectives and Impacts

The primary ecological objectives of MPAs are to conserve biodiversity and to enhance fishery yields were other forms of fishery management do not work (as may often be the case in developing coastal nations with low institutional capacity for management). In the past, MPAs have typically been small no-take areas (“marine reserves”) often implemented at sites with particularly healthy coral reef habitat. Management of these marine reserves involves a ban on harvesting but rarely any regulation of activities occurring outside the reserve (e.g. upland deforestation, road building, etc.). Currently, managers are moving to a paradigm of larger MPA networks implemented within a “ridge to reef” approach to ecosystem-based management, where MPAs, watershed management, and wise land-use practices are included in an integrated coastal management regime.

Key lessons learned and recommendations

- Address management of coral reef MPAs through integrated and holistic management of related ecosystems and land uses. Address all ecosystem components and processes to maintain the full range of ecological interactions, and to aim for resilience rather than for desired end-points.
- Implement management at ecologically relevant scales such as watersheds, monitoring the status and trends of systems over long time periods and incorporate marine protected areas into management frameworks.

- Integrate issues of sedimentation and sediment re-suspension into coastal reef protection, or further declines in resources will continue to occur. MPAs should be part of an integrated “ridge to reef” management plan that includes wise land use practices and watershed management.
- Provide fishing communities with accurate and realistic predictions of MPA benefits; avoid “overselling” MPAs on the basis that increased catches due to spillover and enhanced recruitment from spawning in the MPA will more than make up for lost fishing grounds, increased effort and higher costs of fishers displaced from the MPA.
- Obtain comprehensive biological and biophysical datasets before designing MPA networks. Where possible, conduct research to determine critical spawning and nursery habitats, connectivity pathways, and resilience of habitats, ecosystems, and livelihoods.
- Incorporate a range of fishery management tools and avoid reliance on MPAs only. Other methods of restricting catch and/or effort are valuable, do not displace fishers, and may cause fewer conflicts between fishers and other reef resource users.
- Monitor marine resources and ecosystem health within MPAs. Without monitoring, you can evaluate neither the success nor cost effectiveness of MPAs, nor carry out adaptive management if needed.
- Set up and monitor a few comparable “control” areas where no regulations or conservation activities are In place. These provide a clear baseline against which you can evaluate the cost-effectiveness of your MPA.

ISSUE 2: Socio-cultural Objectives and Impacts

MPA managers generally agree that most challenges to MPA implementation are social. Reef-dependent communities need to be resilient and coexist with the ecosystem, not suffer from bad practices. This “social resilience” is the ability of the community to deal with change, through learning, reorganizing, self-organizing, and combining knowledge. It is crucial to recognize the diversity of communities and be flexible. Thus MPAs need adaptive management and monitoring to evaluate the effectiveness of their management in meeting community goals.

Key lessons learned and recommendations

- Design MPAs to meet community goals and achieve greater compliance and subsequent conservation success.
- Collect and integrate indigenous knowledge to avoid conflicts in zoning.
- Use GIS and participatory mapping tools for zoning and rationalising roles and responsibilities among government organisations and other stakeholders.
- Educate people about the zone boundaries and permitted uses, alongside training in ways to reduce human threats.
- Base local MPA management plans on locally perceived threats/issues and sound data on local resource status.
- Focus MPA management on the socio-cultural conditions and needs of communities. Incorporate formal workshops, participatory training exercises and community development to build trust and achieve stewardship of the MPA planning process.

- Translate the goals and objectives of the MPA such that they are understandable to the target audiences and the community context.
- Create a forum for stakeholder interaction, query, and debate to provide opportunities for collaboration and mediation within the context of social interactions and conflicts.
- Involve marginalised user groups (gender and ethnic equality) and functional community leaders to promote good will, improve project management, and ensure equitable distribution of benefits.
- While permanent reserves are more effective, rotational or seasonal closures or regulations other than complete closures are often more accepted, have less immediate social impacts and are easier to monitor and enforce.

ISSUE 3: Economic Objectives and Impacts

In order for MPAs to be sustainable, management must contribute to economic returns and livelihood. Reef-dependent communities that do not see any sign of increased economic returns from their MPA are unlikely to continue to support it. MPAs are often “oversold” on the promise of higher fishery yields through increased spawning biomass and spillover. However, the value of this increased production is difficult at best to quantify at the time of implementation.

Key lessons learned and recommendations

- Clearly identify and communicate economic and other benefits of MPAs to maintain stakeholder interests and manage expectations.
- Evaluate costs and benefits of private sector involvement early in the MPA development to assure buy-in and long-term engagement.
- MPAs will have higher compliance and be more effective at conserving resources if they are easily visible to the community, and compliance is likely to increase the longer the MPA remains enforced.
- MPAs will be more effective if implemented in communities with less market influences (i.e., proportion of fish sold or bartered and involvement in formal economic activities such as teaching, government employment, and other salaried positions), lower population sizes, and less wealth.
- Where fishers or other resource users are likely to be displaced, provide realistic, long-term options for alternative livelihoods (e.g. ecotourism, catch-and-release sport fishing, seaweed farming, etc.).

ISSUE 4: Governance of MPAs

Governance of MPAs includes a wide array of policies, strategies, institutional arrangements, legislation, information and education, financing mechanisms and capacity development. It involves the delineation of the roles and responsibilities of the various agencies and stakeholder groups involved in management.

Key lessons learned and recommendations

- Explore bottom-up and co-management approaches, recognising that varying management structures and strategies improves MPA effectiveness.
- MPA regulations need to be pragmatic and address root causes but not be unrealistic in the ability of people to change their behaviour.
- Zoning requires knowledge gained through a participatory process and that is well integrated with tools such as participatory mapping and GIS.
- Policies that include more than one jurisdiction will require time to integrate and may often need to be agreed on prior to implementation.
- Rapid and fair enforcement is essential to achieve continued support, faith, and compliance in MPA management.

Case Studies

Issue 1: Ecological Objectives and Impacts

MPA and ecosystem-based management should fundamentally work intrinsically as only this framework would allow the perception of a larger picture in recognizing the connections and also strive to maintain the elements of ecosystems and the processes that essentially link them. Below are several case studies that identify the importance of integrated and holistic management of related ecosystems.

Recommendation 1.1

Address management of coral reef MPAs through integrated and holistic management of related ecosystems and land uses. Address all ecosystem components and processes to maintain the full range of ecological interactions, and to aim for resilience rather than for desired end-points.

Case Study 1.1a: Coastal Management Plan in Belize. (Gibson, J., M. McField and S. Wells. 1998. Coral reef management in Belize: an approach through Integrated Coastal Zone Management. Ocean and Coastal Management 39: 229-244)

Management of the coral reef must extend to land-based activities outside marine reserves if reefs are to be protected from siltation and land-based sources of pollution, the approach of integrated coastal zone management should be chosen to ensure the long- term viability of both the protected areas and the reef system in general. Although Belize hosts a small population of community, the unmonitored practices of agriculture has caused significant eutrophication caused by the damaging quantities of fertilizers from the citrus fruit cultivation farm which enters into the coastal waters from the Stann Creek Watershed. Apart from agriculture, sedimentation of corals has been reported at localized sites with high number of visitors, divers and snorkelers. In addition, destruction of mangroves and sea grass beds results from illegal dredging and sand mining operations. These detrimental practices are not kept under control due to the lack of monitoring and enforcement.

In response to these issues, management of the coral reefs was extended to land-based activities outside marine reserves and hence the Coastal Zone Management Unit (CZMU) was established in Belize with close cooperation with the Fisheries Department, the Belize Tourist Board (BTB), the Belize Port Authority (BPA), DOE and the Coastal Zone Management Project (CZMP) to develop policies and legislation for tourism and recreation.

Case Study 1.1b: Mindanao Rural Development Project. (Zweig, R. 2006. Mindanao Rural Development Project. Implementation Completion Report TF 23302. The World Bank, Rural Development and Natural Resources Sector Unit, East Asia and Pacific Region)

The overall objective of the long-term Mindanao Rural Development Program (MRDP) is to reduce poverty and ensure food security for the rural poor and indigenous communities in 25 provinces of Mindanao through the implementation of better-targeted agricultural and fisheries-related rural development and biological diversity conservation programs and through improved institutional, technical, management and financial capabilities and systems of participating local government units (LGUs). MPAs were implemented at two sites: Paril-Sangay and Bongo Island.

A resource assessment survey was carried out to generate comprehensive baseline information that will provide the biophysical and social bases for management of the marine protected areas in the Paril-Sangay and Bongo project sites and at the same time, to serve as the venue for the initial capacitation and involvement of stakeholders in the management of their area. The landscape cum oceanographic approach was employed as the general assessment framework of the resource assessment. This approach combined and highlighted the interrelationship between the biophysical environment and the social dimension that influences human activities impacting on the environment. Specific information generated as follows: a. In the biophysical assessment, condition/degree of disturbance in the ecosystems both coastal and forest, the status and value, both ecological and economic, of the species existing therein and, the areas of ecological processes critical in maintaining biodiversity in the area were identified; b. In the social assessment, demographic information such as population and population trends, economic activities and anthropogenic activities affecting the environment were likewise established.

Over a 3-year period from 2002 to 2005, catch per unit effort (CPUE) of the reef fishery in the Paril-Sangay area improved 97.4%. This was attributed primarily to the reduction in destructive fishing practices. At Bongo Island, the increase in CPUE over the same period was only 9.4%. Branching coral cover in shallow (3 m) waters increased by 27% at Paril-Sangay and 38% at Bongo Island. However, in deeper waters (10 m), branching coral cover decreased by 47% at Paril-Sangay and 14.3% at Bongo Island. This decrease in deeper coral cover was attributed to a crown-of-thorns starfish outbreak in 2004 and to other environmental disturbances, particularly sedimentation. Sedimentation was noted to be a major problem in the coastal/marine waters of Paril-Sangay and Bongo Island. Paril-Sangay's biophysical make-up exemplifies a varied landscape system characterized by rugged terrestrial landscape interconnected to its coastal/marine waters and a small but productive agricultural land. The integrity and productivity of its marine ecosystem is therefore closely linked to its forest watersheds which unfortunately have undergone various forms of exploitation and degradation resulting in soil erosion. Bongo Island, on the other hand, typifies a small and fragile island ecosystem surrounded by coastal waters whose productivity is linked to the large Rio Grande River in the mainland which carries sediments from its headwaters in the uplands. As a result, the impacts of soil erosion from upland activities were cited as the major contributors to the degradation of the Paril-Sangay and Bongo Island coastal ecosystems and limiting the recovery of the coastal resources. The project concluded that the

implementation of the watershed approach should be considered in order to promote a management continuum from the upland to the coastal zone.

Recommendation 1.2

Implement management at ecologically relevant scales, monitoring the status and trends of systems over long time periods and incorporate marine protected areas into management frameworks.

Case Study 1.2a: Effects of marine reserve size on reef fisheries in the Turks & Caicos Islands. (Rudd, M.A and M.H. Tupper. 2002. Species-specific impacts of a small marine reserve on reef fish production and fishing productivity in the Turks and Caicos Islands. Environmental Conservation 29: 484-492)

Marine reserves are widely considered to potentially benefit reef fisheries through emigration, yet the empirical basis for predicting the extent of this for small reserves is weak. This study examined the effects of implementing a small (4 km^2) marine reserve on biomass and catch per unit effort (CPUE) of three species of exploited reef fish at South Caicos, Turks and Caicos Islands.
Mean size, density, and biomass of hogfish (*Lachnolaimus maximus*) were higher in a small (4km2) marine reserve than on fished reefs, as was biomass of white margate (*Haemulon album*). CPUE of hogfish was inversely related to distance from the centre of the reserve, suggesting that spillover of this species from the reserve to adjacent reefs may enhance local yields, possibly providing economic incentives for fishers to comply with reserve regulations.
Fishing pressure, however, had no apparent effect on Nassau grouper (*Epinephelus striatus*).

Little is known of the specific movements or home range size of exploited coral reef fishes. In general, it is understood that the longer the time spent outside the reserve, the more vulnerable fish become to fishing mortality and that the extent of home range is most strongly influenced by body size. Large and schooling species have larger home range sizes and tend to move further than small or solitary species. Larger fishes such as grouper are therefore more likely to cross reserve boundaries, while smaller species may spend all their time within MPA boundaries.

The home range of Nassau grouper has been studied by Bolden (2002) in the Exuma Cays, Bahamas. She found that a 60 cm FL grouper (a typical adult size at South Caicos) had a home range area of approximately 18 000 m^2. The total area covered by the ACLSNP is 4 km^2 (slightly larger when considering suitable habitat within the adjoining East Harbour Lobster and Conch Reserve). Home range sizes of hogfish and white margate are currently unknown, but Kramer & Chapman (1999) analyzed the relationship between body size and home range size for 29 species of reef fish, including members of the families Labridae and Haemulidae. Assuming an average fork length of about 250 mm for both hogfish and white margate, the estimated home range areas of these smaller species would be 600 m^2. These are obviously rough estimates, taken from a conglomerate picture of other species. However, it is likely that the home range of adult Nassau grouper is large enough for this species to regularly cross the boundaries of the ACLSNP, while hogfish and white margate have home ranges many times smaller than the protected area.

In summary, larger fishes and those that migrate to spawn, such as economically valuable Nassau grouper, may move over too large a range to be effectively protected by small marine reserves. Small reserves may not protect all fish, but they can increase the biomass of smaller or more sedentary reef fishes and may be a useful tool for the conservation or management of species such as hogfish. Other policy options, such as seasonal spawning closures or total allowable catches, need to be considered for larger, more mobile fishes in the Turks and Caicos Islands.

Case Study 1.2b: Marine protected area status on coral reef fish assemblages in the Hawaiian archipelago. (Friedlander, A.M., E.K. Brown, P.L. Jokiel, W.R. Smith and K.S. Rogers. 2003. Effects of habitat, wave exposure, and marine protected area status on coral reef fish assemblages in the Hawaiian archipelago. Coral Reefs 22: 291-305)

A comprehensive MPA management plan for the fishery resources in the main Hawaiian archipelago was designed by taking into account the various ecological scales that influence and interact with reef fish assemblages. The global concern regarding the poor performance of conventional fisheries management has led to increased interest in marine reserves as a solution to the problems of overfishing. However, for the marine protected area to function effectively in sustaining fisheries production and the conservation, the design of this MPA considered and evaluated the relationships between fish assemblages, their associated habitats, and the degree of protection from fishing over a broad spatial scale throughout the main Hawaiian Islands.

Marine protected areas should encompass the habitat requirements and life histories of the species to be conserved – taking into account the fishing pressure in the area and the degree of enforcement. The Hanauma Bay (Oahu) and Honolua Bay (Maui) are examples of no-take areas with the highest levels of protection from fishing; which also have the highest values for most fish assemblage characteristics. Both areas also have high coral cover, high coral species richness, and/or high reef complexity, suggesting that a combination of these parameters contributed to good fish habitat quality for reef fish in Hawaii. This suggests that a well-designed MPA should also map the distribution and characteristics of benthic habitat within and outside the MPA besides creating an inventory and assessment of the species of interest. This underscores the need for sound land-use management to protect the marine ecosystem from degradation, which will subsequently affect reef fish assemblages.

After the establishment of the MPA, long term monitoring was required to determine the effectiveness of the zoning plan, as a guideline for any modifications needed to reach the desired goals. Such monitoring indicated that the limited-take Pupukea site did not enhance fish stock biomass compared to other, no-take marine reserves. The Department of Land and Natural Resources, Division of Aquatic Resources thus took action by planning for expansion of the existing boundaries and restriction of most fishing activities within the Pupukea reserve.

Recommendation 1.3

Integrate issues of sedimentation and sediment re-suspension into coastal reef protection, or further declines in resources will continue to occur. MPAs should be part of an integrated “ridge to reef” management plan that includes wise land use practices and watershed management.

Case study 1.3a: Large- scale model of reef degradation and impact of future anthropogenic activities in the Great Barrier Reef. (Wolanski E, Richmond R, McCook L, Sweatman H. 2003b. Mud, marine snow and coral. reefs. American Scientist 91: 44-51)

This study presents a large-scale model for understanding reef degradation and predicting the impacts of human activities based on the extensive physical and biological data acquired from the Long- term Monitoring Program at the Australian Institute of Marine Science.

Disturbances from sedimentation are one of the detrimental examples that affected 2 key parameters that will determine a reef’s resilience which is water and substratum quality. Not only will the resident coral reefs at the area affected by sedimentation will fail to thrive but coral larvae arriving from adjacent and more pristine reefs are also unable to recruit on the degraded substratum. A sure tell- tale sign that a degraded reef often gave away is the presence of filamentous and fleshy algae that replaces live coral covers. Ultimately the coral population of that area will fail to recover and also fail to reestablish themselves.

Taking examples from Guam and Hawaii, a reef that was killed cannot be simply restored by importing outside corals until and unless the underlying cause was addressed- which in that case, was soil erosion in the adjoining catchment which caused heavy sedimentation which shouldered the corals. A muddy plume during a river flood from the Burdekin River in Queensland is another instance where its impact has reduced salinity and caused acute damage to the coral reef.

In Australia, there are 4 agencies that deal with land-based issues while only 2 deal with coral reefs. This demonstrates that land-based activities and coral reefs are managed independently as though they are not interconnected ecosystems. This disconnection inevitably results in degradation of coral reef environments throughout the world. The model predicts that if the intensity of human activities on land is not diminished, the zone of damage will continue to expand larger than the natural state.

Among the approaches to alleviate the degradation of the reefs caused by sedimentation are: control of poor land-use practices that spill mud, nutrients and pesticides onto coral reefs; managing fisheries through quotas and fishing-gear restrictions; reducing tourism impacts and establishing marine protected areas which are integrated into coastal management regimes.

Case Study 1.3b Integrating Coral Reef Ecosystem Integrity and Restoration Options with Watershed-based Activities and MPAs in Micronesia. (R.H. Richmond, T. Rongo, Y. Golbuu, S. Victor, N. Idechong, G. Davis, W. Kostka, L. Neth, M. Hamnett and E. Wolanski. 2007. Watersheds and coral reefs: conservation science, policy, and implementation. BioScience 57: 598-607)

Studies were performed to determine the types and magnitudes of impacts caused by poor land-use practices within watersheds on adjacent coral reef ecosystems on Guam, Palau and Pohnpei. The overall study was aimed at identifying the biological and physical parameters affecting the coral reef communities, as well as the social aspects of policy development and implementation within the adjacent human communities. At all three sites, the local communities were involved in the project scope, design and the application of the research results.

In Guam, Fouha Bay was chosen as the research site. It is surrounded by steeply sloping hills that are often burned to clear vegetation by deer and pig hunters, accelerating erosion rates. The mayor and community members requested research to be performed in their village, and provided logistical support. Studies revealed high rates of sedimentation related to runoff from rain events, high levels of oceanic swell-induced mud re-suspension in the absence of additional rainfall, and high levels of sediment retention in algal mats smothering the coral reefs and preventing the recruitment of coral larvae. Sedimentation had significant impacts on coral community composition over the entire 300m-long bay. Riverine sediment input exceeded sediment flushing by a factor of two, on an annual basis.

In Palau, Airai Bay was chosen, which is bordered by a substantial mangrove forest, and is impacted by sedimentation from upland clearing for a road, farms and a housing development. The mangroves had a significant buffering effect, reducing the sediment load reaching Airai bay by approximately 30%. These mangroves were being cut and filled to make room for houses. The impact of this activity was immediately evident, as the area of coral mortality spread 150m further into the bay soon after the clearing commenced.

In Pohnpei, the Enipein watershed was selected for study. The key concern within this watershed is the clearing of the upland rainforest for sakau (a narcotizing plant and major cash crop) farming, which has resulted in extensive erosion and subsequent sedimentation of the mangrove-fringed estuary and the coral reefs. The sedimentation data demonstrated that the coral reef community within the designated MPA was being impacted by the watershed discharges, reducing the value of the marine conservation effort alone.

Specific problems tied to human activities responsible for sedimentation effects on the reefs were identified at all three sites. A set of scientifically sound approaches for reversing the negative trends in reef health were provided to each community.

Two important points arising from this study are that:

(1) Coral reefs and other coastal marine ecosystems effectively extend into adjacent watersheds, and should be managed as an integrated unit. Marine protected areas often will miss their targets of resource protection unless they are coupled with effectively enforced terrestrial protected areas (TPAs).
(2) Accumulated sediment is lethal to coastal coral reefs undergoing phase shifts due to increased nutrient input and the overfishing of herbivorous species. These sediments are often re-suspended by waves, preventing larval recruitment and thus the recovery of affected populations. Sediments also serve as a repository of pollutants associated with anoxic bottom sediments. Until these issues are integrated into coral reef management, further declines in resources will continue to occur.

Recommendation 1.4

Provide fishing communities with accurate and realistic predictions of MPA benefits; avoid "overselling" MPAs on the basis that increased catches due to spillover and enhanced recruitment from spawning in the MPA will more than make up for lost fishing grounds, increased effort and higher costs of fishers displaced from the MPA.

Case study 1.4a: Rates of fish recovery in marine reserves in the Philippines. (Russ, G.R., Stockwell, B. and A.C. Alcala. 2005 Inferring vs. measuring rates of recovery in no-take marine reserves. Marine Ecology Progress Series 292: 1-12)

Russ et al. (2005) used underwater visual census at 15 no-take marine reserves in the Philippines to both infer and measure recovery of reef fishes. They made a single estimate of the biomass of large predatory reef fishes (Serranidae, Lutjanidae, Lethrinidae) heavily exploited by fisheries in each of 13 well protected no-take reserves (age range 0.5 to 13 yr), and in nearby fished sites. They also measured rates of biomass increase of these fish regularly for 18 yr (1983 to 2001) in 2 no-take reserves (Sumilon, Apo) and fished sites. A minimum of 3-4 years was required to measure significant increases in biomass within a reserve, but at least 6 years was needed to measure significant differences in biomass between reserves and adjacent nonreserve sites). The reserve:nonreserve biomass ratios at maximum duration of reserve protection were similar for inferred (9.0) and measured (6.3 to 9.8) estimates. An index of habitat complexity did not significantly affect estimates of recover, and reserve protection was generally effective. Thus, using similar methods of reserve protection and census on the same species in similar areas, one can make useful inferences about rates of recovery in no-take marine reserves. Such inferences are clearly not definitive, and should be viewed merely as guides to possible recovery rates. There is no substitute for properly designed monitoring studies that can not definitively determine recovery rates and also provide information on the mechanisms driving recovery rates.

In a related study (Russ and Alcala 2004), the authors noted that after 9 years of protection at Sumilon Island and 18 years at Apo Island, the biomass of large predatory fishes was still increasing exponentially. Furthermore, there was little evidence that the rate of recovery of biomass inside the reserves was slowing down even after many years of protection. This led the authors to suggest that a considerable length of time is needed for full recovery to occur. They concluded that the time required for full recovery will be 15 at Sumilon Island and 40 years at Apo Island. This length of time is consistent with the life history characteristics of large predatory fish (e.g. slow growth, large body size, and late maturation), and with empirical data on recovery rates of heavily exploited fish stocks. The authors point out that by the time the full benefits from no-take marine reserves are apparent, human populations and impacts will have doubled in much of the developing world. They therefore recommend that, networks of no-take marine reserves need to be implemented immediately and that management mechanisms for such reserves need to be successful over timescales of human generations.

In an earlier study of the same reserves, Russ and Alcala (1996) suggest that much of the strong recovery in large predator density was due to a strong recruitment of the serranids (grouper). Almost 5 years of protection from fishing at Sumilon reserve resulted in a significant increase in density (but not biomass) of large predators. The authors suggest that biomass did not increase because the fishes did not have time to grow to significantly larger sizes before they were fished again after the reserve was reopened. Thus, it is important to consider the recruitment strength and life histories of the targeted fish species as these can influence the perceived effectiveness of the marine reserves to replenish fish stocks through spillover. It is not valid to expect that recruitment will be immediately successful following the closure of a reserve area –it is even possible that successful recruitment may not occur for several years following reserve implementation.

Case Study 1.4b: Recovery of reef fishes in Kenyan marine protected areas (McClanahan, T.R. and N.A.J. Graham. 2005. Recovery trajectories of coral reef fish assemblages within Kenyan marine protected areas. Marine Ecology Progress Series, 294: 241–248)

Recovery of reef fish assemblages following protection from fishing has implications for the design of the closed areas. Determining the equilibrium abundance and structure of the exploited species is an important reference point in conservation and harvesting models and decisions. This study examined the recovery of biomass and size structures of coral reef fishes on southern Kenyan coral reefs in four fully closed MPAs with varied ages since establishment. The goal was to determine whether there are consistent and general patterns and equilibrium levels for fish biomass and size structure. The results of the study indicated that over 20 years is needed for coral reef fish to recover to their full biomass in Kenya. Full recovery is likely to be dictated by periodic recruitment patterns, growth and longevities of the fish.

Although the maximum biomass was 1200kg/ha after about 20 years of recovery, it appeared that beyond 20 years there was a small decline in biomass. This decline could be caused by site-specific patterns and may be an artifact of the low overlap between sites and time under closure. However in the case where the decline is not an artifact, it could be due to slow recovery processes, changes in benthic cover, decline in net production, density-dependent emigration of fishes from older parks and recovery of higher trophic level prey. Given that biological overfishing occurs when the stock falls below half of the pristine biomass, the value of 1200kg/ha (for fish >10cm) will provide a good basis for estimating the stock condition and providing a target for fish biomass on fished reefs in this region. It is critically important for nations with coral reef fisheries to adopt multiple, fully closed areas that are permanently and properly enforced for many years. Periodic harvesting could be a useful form of fisheries management and it should be employed together with permanently closed-area management.

Case study 1.4c: Net spillover of reef fish biomass from a marine protected area in Guam. (Tupper, M. 2007. Spillover of commercially valuable reef fishes from marine protected areas in Guam, Micronesia. Fishery Bulletin 105:527-537)

This study addresses the question of whether adult spillover (movement out of marine protected areas) of fish can create a net export of fish biomass from MPAs to adjacent fished reefs. Biomass of five commercial reef fish species was estimated by visual census within and outside three MPAs in Guam, Micronesia. For most species and sites, biomass was significantly higher within the MPAs than in adjacent fished sites. Movement of fishes into and out of the MPAs was determined by mark-recapture experiments, in which fishes were tagged both inside and outside of MPAs. Four out of five species studied showed little or no net movement out of MPAs. However, the orangespine surgeonfish (*Naso lituratus*) showed a net spillover of biomass from all three MPAs; 21.5% of tagged individuals and 29% of the tagged biomass emigrated from MPAs.

Patterns of spillover were strongly influenced by physical habitat barriers, such as channels, headlands, or other topographic features. The study suggested that MPAs that are physically connected by contiguous reef structures will provide more spillover to adjacent reefs than those that are separated by habitat barriers. This study demonstrates that MPAs can enhance export of fish biomass to fished areas, but spillover is species-specific and depends on factors such as species size and mobility. To date, this is the only study that has directly demonstrated net export of adult biomass from an MPA to surrounding fished areas.

Recommendation 1.5

Obtain comprehensive biological and biophysical datasets before designing MPA networks. Where possible, conduct research to determine critical spawning and nursery habitats, connectivity pathways, and resilience of habitats, ecosystems, and livelihoods.

Case study 1.5a: Identifying nursery habitat for key reef fish species in Palau. (Tupper, M. 2007. Identification of nursery habitats for commercially valuable humphead wrasse (*Cheilinus undulatus*) and large groupers (Pisces:Serranidae) in Palau. Marine Ecology Progress Series 232: 189-199)

Among the most economically valuable and most vulnerable coral reef fishes are the large-bodied species such as large wrasses and groupers. These species are slow growing and long lived, with late maturity, spawning occurring in aggregations and low rates of replenishment (Rhodes & Sadovy 2002, Sadovy et al. 2003a,b). These life-history traits render them particularly vulnerable to overfishing and catches have dramatically declined over the past few decades (Donaldson & Sadovy 2001, Myers 1999). The humphead wrasse has been listed as 'vulnerable' on the IUCN Red List of Threatened Species, (www.redlist.org) and was listed in Appendix II of the (CITES) in. In addition to their fishery value, large reef fishes are important to recreational divers and may have high tourism value (Rudd and Tupper 2002).

Using mark–recapture techniques, Tupper (2007) examined among-habitat variation in settlement, growth, persistence, and movement in 3 large, vulnerable reef fishes: the humphead wrasse *Cheilinus undulatus*, the squaretail coralgrouper *Plectropomus areolatus*, and the camouflage grouper *Epinephelus polyphekadion*. All three species are culturally and economically important throughout the Indo-Pacific region. Both *C. undulatus* and *P. areolatus* appeared to utilize specific nursery habitats. Settlement, growth, and persistence of humphead wrasse were highest in branching coral mixed with bushy macroalgae (BCMA). Moreover, 80% of tagged *C. undulatus* recaptured in intermediate or adult habitats were originally tagged in BCMA. Early juvenile *P. areolatus* were found almost exclusively in coral rubble habitats on the slopes of tidal channels, at a narrow depth range of 5 to 7 m. This same pattern was found for *P. leopardus* on the Great Barrier Reef (Light and Jones 1997). This dependence on one habitat type could render this species vulnerable to dredging operations or other forms of coastal development. *E. polyphekadion* appeared to be a habitat generalist, and no specific nursery habitat could be identified for this species.

In summary, implementation of marine protected areas should prioritize habitats for conservation according to their value as essential nursery or spawning habitats for target species. However, the formation of a new Protected Areas Network in Palau has yet to include nursery habitats, primarily because information on such habitats did not exist. The results of this study demonstrate that nursery habitats do exist for some commercially and culturally important reef fishes in Palau, and that some of these nurseries (e.g. rubble areas along the slopes of tidal channels) could be easily impacted by human activities, with potentially serious consequences for fish populations. Future land-use planning and spatial management efforts should account for nursery areas in addition to spawning sites.

Case study 1.5b : Reef fish larvae dispersal of Cairns in the Great Barrier Reef. (Bode, M., L. Bode and P.R. Armsworth. 2006. Larval dispersal reveals regional sources and sinks in the Great Barrier Reef. Marine Ecology Progress Series. Volume 308: 17-25)

The connectivity patterns for reef fish larvae was analyzed in Cairns and it was found that a few local populations known as "gateway reefs" which functions to transport larvae from the sink subregion to the source subregion. This reef maintains the connectivity of the both populations in these two subregions hence the role of "gateway reefs" needs to be taken into consideration when a marine protected area network is designed.

In the Great Barrier Reef, larval fish recruitment varies regionally and this large scale variation will also affect population dynamics at smaller scales. It was found that the northern subregion of the Cairns coral reef was persistently limited by recruitment with low external larval input, but the opposite was true for the southern subregion (larval sink). The recruitment system was found to be unsustainable without larval input from the northern subregion (larval source).

With this, we now understand that the marine reserve would not have worked to replenish fish stocks if it was only closed around the southern subregion, without closures around the northern subregion and also around the “gateway reefs” which is the area of transit for the larval dispersals. These source-sink population dynamics are critical in siting effective marine protected areas, as pelagic larval dispersal that connects patchily distributed adult populations is a common feature in marine systems.

Recommendation 1.6

Incorporate a range of fishery management tools and avoid reliance on MPAs only. Other methods of restricting catch and/or effort are valuable, do not displace fishers, and may cause fewer conflicts between fishers and other reef resource users.

Case study 1.6: The management of Palau’s coral reef fisheries. (Johannes, R.E. 2002. The renaissance of community-based management in Oceania. Annual Review of Ecology and Systematics 33:317-340)

Proponents of marine protected areas routinely assert that their primary function is protect spawning stock biomass and increase fishery yields via improved recruitment resulting from larval dispersal (Johannes 2000). However, with few exceptions the great majority of Indo-Pacific MPAs have not included spawning aggregation sites. Even Australia, with the world’s largest coral reef, has only recently begun protecting spawning aggregation sites. In this regard, Palau is 20 years ahead of other Indo-Pacific nations, having begun protection of a major grouper spawning aggregation at Ngerumekaol (aka Ulong Channel) since 1976. Another grouper spawning aggregation site at Ebiil Channel is also closed to fishing.

Traditional leaders in Palau once strictly regulated fishing through customary marine tenure and via a system of closed areas, closed seasons, minimum size limits, and a variety of other regulations (Johannes 1999). However, traditional authority has eroded over the past 50 years, and Palauan fishermen requested government intervention to strengthen national fisheries law. Now, in addition to a system of marine and coastal protected areas known as PAN (Protected Areas Network), which includes the Ngerumekaol and Ebiil spawning aggregation sites in addition to other, larger closed areas, Palau has implemented many other regulations, many of which are thought of has contemporary “Western” forms of fishery management. These include seasonal bans on fishing several key species of groupers, a complete moratorium on fishing vulnerable humphead wrasse (*Cheilinus undulatus*) and bumphead parrotfish (*Bolbometopon muricatum*), minimum size limits for sex-changing groupers, minimum mesh sizes for nets and traps, gear restrictions including a ban on SCUBA spear fishing, and a complete ban on destructive dynamite

and cyanide fishing. As a result, Palau has much healthier fish stocks than similar island nations, such as the Federated States of Micronesia, Guam, the Northern Mariana Islands, or American Samoa, all of which have less comprehensive fisheries management systems. Despite this, reef fish populations in Palau still appear to be declining, leading to the introduction of a bill in 2008 to ban all foreign fishing in Palau's 200 mile Exclusive Economic Zone. In summary, Palau is ahead of many other developing island nations in its use of a wide variety of fisheries management approaches (including MPAs), each of which can be considered one tool in a comprehensive toolbox.

Recommendation 1.7

Monitor marine resources and ecosystem health within MPAs. Without monitoring, you can evaluate neither the success nor cost effectiveness of MPAs, nor carry out adaptive management if needed.

Case study 1.7a: The marine protected area design of the US Virgin Islands and its effects on reef fish populations. (Monaco, M.E., A.M. Friedlander, C. Caldow and J.D. Christensen. 2007. Characterising reef fish populations and habitats within and outside the US Virgin Islands Coral Reef National Monument: a lesson in marine protected area design. Fisheries Management and Ecology, 2007, 14, 33-40)

Because species response differently to protection depending on the intensity of exploitation to which they are subject outside the reserve and prior to their establishment, their life history characteristics and their larval, juvenile and adult dispersal- the marine resources and ecosystem health depends much on the suitability of the species adapting to such responses consequent of a marine protected area.

An effective MPA that should protect representative habitats and species types – constant monitoring of the health of these marine resources and ecosystem health must be done and ensured that the mosaic of these ecosystems are functioning properly. To assess the long- term effectiveness of the MPAs, it is important to characterize the health of the habitats and associated fauna within and outside the MPA. This data will provide a useful baseline for future comparisons and also to support adaptive management actions and also to assess the change within the ecosystems- such as one that was done between Virgin Islands National Park (VINP) and the Virgin Islands Coral Reef National Monuments (VICRNM).

At the end, the success and the effectiveness of every MPA hinges on proper location relative to critical habitats that supports living marine resources.

Case study 1.7b: Long-term monitoring of MPAs and ecosystem restoration in the Florida Keys.

(Keller, B.D. and B.D. Causey. 2005. Linkages between the Florida Keys National Marine Sanctuary and the South Florida Ecosystem Restoration Initiative. Ocean & Coastal Management 48: 869–900)

The Florida Keys is a string of islands extending approximately 400km southwest of the southern tip of Florida, characterized by extensive seagrass beds, mangroves and coral reefs. The greatest threat to the environment, natural resource and economy of the keys has been the degradation of water quality, especially over the past two decades. Among the problems and challenges faced to effectively manage the Florida Keys National Marine Sanctuary (FKNMS) is the large area and the length of the keys, and the large number of resource users. The heavy use of the sanctuary's resources results in substantial resource damage through vessel groundings, fishing gears, hooks and lines entanglements, and from agricultural runoff and freshwater input.

The major element of South Florida Ecosystem Restoration Initiative (SFERI) goal is to restore a more natural water flow to the ecosystem while guaranteeing sufficient regional water supplies and flood control. To monitor environmental changes in the Florida Keys, the sanctuary has implemented a comprehensive program which is complemented by a research program directed at ascertaining the cause and effect linkages. This will ensure the effectiveness of the implementation and evaluation of the management strategies using the best available scientific information. Restoration efforts have adopted an adaptive management approach that stresses rectifying issues where possible and also continual collecting data, learning and planning. All these actions are integrated towards a system-wide management, integrated governance, broad- based partnerships, public outreach and communication and science based decision-making. System-wide management means taking a holistic and systematic approach to address issues regionally, not just locally, and placing emphasis on obtaining results rather than on developing processes that may never be carried out. To achieve this, different levels of government must work together to develop regulations that are based on common sense and sound science, share funding and cut costs, integrate budgets, develop cooperative programs to enable quicker actions and streamline red tape and other institutional barriers. In addition to that, broad-based partnerships are another key element in the restoration effort. The region's high degree of cultural diversity demands for effective communication to connect people in meaningful ways with the effort, foster a clear exchange of views, ideas and information and instill a broad sense of stewardship, ownership and responsibility for the fate of the Florida Keys.

Recommendation 1.8

Set up and monitor a few comparable "control" areas where no regulations or conservation activities are in place. These provide a clear baseline against which you can evaluate the cost-effectiveness of your MPA.

Case study 1.8: Comparing protected sites to fished areas to determine the effectiveness of a Tanzanian MPA. (Kamukuru, A.T., Y.D. Mgaya and M.C. Ohman. 2004. Evaluating a marine protected area in a developing country: Mafia Island Marine Park, Tanzania. Ocean & Coastal Management 47: 321-337.

The benefits of marine protected areas (MPAs) to fish productivity remain debated, and comprehensive research projects have been suggested to assess MPA function. In order to determine the effectiveness of MPAs, it is necessary to compare the protected areas with similar, nearby unprotected sites. This study compared density and size of the blackspot snapper, *Lutjanus fulviflamma*, in Mafia Island Marine Park (MIMP), Tanzania, with adjacent intensively fished areas (IFA) using underwater visual censuses and catch data from the local fishery.

The MIMP is situated south-east of Dar es Salaam in Tanzania. The MIMP was established in 1995 and covers an area of about 822 km^2. Through boat patrols and local community participation, coral mining and destructive fishing techniques such as beach seining and blast fishing have been greatly reduced. Surveillance is conducted on a regular basis and illegal fishers are either fined or their gear and boats are confiscated. Although violations still occur, the fishing pressure is considerably lower in MIMP than in intensively fished areas (IFA).

This study was conducted on patchy reefs at two sites in MIMP and at two sites fished outside the park during September/October 2000. For a rapid assessment at low cost that would provide useful data on the local communities, the study was limited to one target species. Numbers and size structure of *L. fulviflamma* were estimated by underwater visual census along 50m belt-transects laid on the reef at 2–15m depth. The observers swam along the tape at a constant speed (approximately 20m per minute) while counting and recording individuals in 5 cm total length (TL) intervals. In addition, fishery data (i.e. number of fishers, fishing boats and gear) were obtained from a survey conducted by the Mafia Island District Fisheries Office in March 1999.

The results indicated that the target species was over four times more abundant, its biomass six to ten times higher and individual sizes on average 37% larger within the MIMP compared to the IFA. In comparing MPAs to control sites, it is important to account for the effects of habitat and other factors that may influence fish abundance or distribution. In this study, fish numbers and biomass were negatively correlated with fishing intensity and positively correlated with hard coral cover and structural complexity. Moreover, hard coral cover and structural complexity were higher in the MIMP than in the IFA. Thus the observed higher abundance, biomass and average size in the MIMP likely results from a combination of lower fishing pressure and superior habitat quality within the MIMP compared to the IFA.

Issue 2: Socio-cultural Objectives and Impacts

Although MPAs are expected to generate various biological and social benefits, there is a concern about over-zealous advocacy and impractical expectations of what MPA can realistically deliver. Without the relevant socio-cultural scales as guidelines, this often contributed to the flawed planning where MPA management adopts uninformed designs and the reckless proliferation of it will ultimately lead the design to suffer an imperative failure in due time.

Recommendation 2.1

Design MPAs to meet community goals and achieve greater compliance and subsequent conservation success.

Case study 2.1a: Community participation in the management of marine resources in Kenya
(McClanahan, T.R., S. Mwaguni and N.A. Muthiga. 2005. Management of the Kenyan coast. Ocean and Coastal Management 18 : 901-931)

One of the common shortcomings in designing an effective marine protected area is the failure to ensure local community involvement in the critical phase of decision making. In the management of marine resources in Kenya, this issue was avoided by encouraging the participation between sectors in the meeting where the responsibilities of management were agreed upon and from which a number of memorandums were initiated as part of the integrative process.

It is often that where government and the larger economic interested that are involved in the policy planning, the poor and closely associated communities were marginalized. It is the exploitation of the local communities that will inevitably affect the natural environment of the coast – thus without proper and thorough planning of the MPA design to consider fulfilling the community goals and their participation to ensure the sustainability of the reserve, an MPA design will cease to work once it hits that gap of design.

ICM as a government process will subsequent in the historic top-down approach during initiation and marginalize the direct voice of local communities- which have their own system of organization with established traditions. This scenario illustrates the case where community goals are given proper considerations along with their traditional management – which will inevitably consequent in lower compliance and conservation successes.

Official stakeholders need to accept the need to subordinate their positions of decision making to local community leaders – so to avoid having the local communities to be suspicious of changes in the new ICM process that not only will avoid mistrust and conflict at the inception of the ICM process but also to adopt a design that meets the community goals.

Case study 2.1b: Community-based resource management in Southeast Asia. (Ferrari, M.F. 2006. Rediscovering community-conserved areas in South-east Asia: peoples' initiatives to biodiversity loss. Parks 16: 43-48)

Human settlements have been shaping South-east Asia's environment for thousands of years. But major social, economic and political changes in the past two centuries have had a tremendous impact on biodiversity and people. About 50% of coral reefs are threatened (Burke *et al*., 2002) and 65% of mangroves lost (UNEP 2001). Most of this loss has been taking place since local communities were earlier deprived of their use and control of local resources by colonial administrations and since the 1970s by industrialization and global trade policies. Simultaneously, since the 1980s, some governments started to admit that since they have not succeeded in sustainably managing natural resources, local communities and indigenous peoples need to be involved. Traditional and indigenous knowledge systems have also been gaining recognition in this context.

In the past three decades, although supporting legal instruments are only now evolving, there are increasing community conservation initiatives and community involvement in nongovernmental organization (NGO) or government conservation initiatives. While there is no fully reliable data on the exact number or the total area covered by community conserved areas (CCAs), there are more than 500 community-based coastal resources management (CBCRM) initiatives in the Philippines , as well as a growing number in Indonesia and Cambodia. Not all these local initiatives are operating successfully, but learning networks are being set up to help overcome shortcomings. The wide variety of CCAs are of three categories: (i) based on traditional and customary beliefs and practices; (ii) externally motivated (NGOs, Government agencies, donor agencies); and (iii) a combination of these two.

Many CCAs in the region have been started as a means by which communities claim their rights over their traditional lands and resources, be it common forests, watershed and wetland areas, or fishing grounds. Addressing unequal relations and enhancing equity therefore requires a critical look and a creative approach to power relations and the political economy of resource management, to ensure a favorable policy and legal environment for CCAs.

Traditional knowledge, conventionally ignored in formal conservation circles, is increasingly being shown to provide important lessons and tools in the search for new conservation approaches. Such knowledge and practices still play an important role in biodiversity management or are being revived. Emphasizing traditional knowledge, however, does not mean rejecting modern knowledge or technology. For example, many indigenous communities have been carrying out community resource mapping, using a combination of traditional knowledge and sophisticated GPS and GIS tools, to document their customary use of resources and develop sustainable management plans. Despite this, it does not seem that governments and, in many cases, NGOs are paying enough attention to stopping the erosion of traditional knowledge and customary practices in order to employ them in practical initiatives. Indigenous and local communities also point out that traditional knowledge and customary use can only be practiced if their rights to land and resources are secured.

Many communities have started to address concerns about being marginalized in decision-making. In the Philippines, coastal fishers have formed an extensive network of Community-Based Coastal Resource Management (CBCRM) initiatives throughout the country. They have set up more than 500 marine sanctuaries, and developed the concept of Community Property Rights, which could apply to terrestrial resources as well as coastal and marine resources. The CBCRM Resource Centre in Manila has been serving communities, and has linked up with people and initiatives in Indonesia, Cambodia, Viet Nam and Thailand in a project called CBCRM Learning Regional Network (CBCRM LeaRN).

Recommendation 2.2

Collect and integrate indigenous knowledge to avoid conflicts in zoning.

Case study 2.2a: Fishermen's knowledge – a traditional system in local resource management in Brazil. (Colding, J. and C. Folke. 2001. Social Taboos: "Invisible" Systems of Local Resource Management and Biological Conservation. Ecological Application, 11 :584-600)

Social taboos and indigenous (local) knowledge are good examples of informal institutions, where norms rather governmental juridical laws and rules, determine a human behavior which also then will determine their reactions and responses towards the implemented management. In Brazil, fisherman's knowledge of fishing resources has the potential to be an important source of information to improve artisanal tropical fisheries management.

In this study, the researchers has interviewed selected fisherman with more than 30 years of fishing practice. Their results indicate some general patterns in fish reproduction according to fisherman's knowledge such as fish spawning habitats, reproductive seasons and migratory patterns.

When their knowledge of ethno-ichthyologic information is compared with available scientific data, it indicates promising insights about reproduction and migration of Brazilian coastal fishes. Studies recording and analyzing fishers' local knowledge is useful to better understand local fishing practices and customary or common management rules. This is also helpful in gathering new biological information about fish ecology aspects, migration, feeding habits and reproduction to improve zoning, impact assessment and to aid in marine conservation.

Case study 2.2b: Customary management for protecting coral reefs. (Aswani, S., Albert, S., Sabetian, A. and T, Furusawa. 2007. Customary management as precautionary and adaptive principles for protecting coral reefs in Oceania. Coral Reefs 26: 1009-1021)

In the Pacific Islands, several factors have contributed to fisheries mismanagement, including poor data and inadequate scientific models, environmental variability, ignorance about natural systems, noncompliance with management measures, and the complex inter-relationships between biological, economic, and socio-cultural systems. In fact, managing small-scale, multi-species, and

multi-gear reef fisheries that are spread over thousands of kilometers is too complex and too expensive for small Pacific Island nations. A number of authors have called for a more holistic approach to fisheries management in the region (e.g., Adams et al. 1997; Ruddle 1998; Sadovy 2005). While community-based natural resource management is widely implemented in the Pacific Islands, local knowledge and practices have yet to be fully integrated into the design, implementation, and monitoring of community-based conservation programs. Furthermore, with only few exceptions (e.g. Cinner et al. 2005; McClanahan et al. 2006), there is little evidence to show whether community-based conservation projects, which emphasize customary management, are meeting their stated objectives of biological conservation, social equity, and food security.

Customary management practices need not be an absolute substitute for more scientific methods of designing MPAs. A better approach is to combine Western and indigenous forms of knowledge and governance and to ensure that management policies that include indigenous practices are sanctioned by, and designed to benefit, local communities. The socioeconomic and cultural factors leading to success or failure of customary management should also be evaluated (Aswani 2005; Cinner and McClanahan 2006). Conservation of natural resources will be difficult to achieve unless the socioeconomic and cultural precepts that are important to people are considered.

Finding alternative means of designing MPAs is particularly important given the lack of reliable data on life history patterns of fish in tropical multi-species fisheries. Such knowledge is crucial for designing MPAs using the rigorous scientific principles advocated by many marine biologists. Given the current rate of marine resource degradation and biodiversity loss, however, it is essential that researchers and conservation practitioners systematically apply customary management practices as precautionary and adaptive management in community-based conservation programs.

Recommendation 2.3

Use GIS and participatory mapping tools for zoning and rationalizing roles and responsibilities among government organizations and other stakeholders.

Case study 2.3: GIS applications in the Kent Group of Islands benthic mapping. (Jordan, A., M. Lawler, V. Halley and N. Barrett. 2005. Sea bed habitat mapping in the Kent Group of Islands and its role in marine protected area planning. Aquatic Conservation: Marine and Freshwater Ecosystems 15: 51-70)

GIS has been gaining popularity as an important tool in the mapping of seabed habitats to identify the distribution of marine ecosystems and as a surrogate measure of biodiversity for marine protected area planning. In designing the parameters of the Kent Group of islands, southern Australia- six distinct habitat types managed to be identified based on visual differences, proving that the application of GIS and the development of remote sensing techniques have improved the cost- effectiveness and reliability of habitat mappings. Although the Kent group are not tropical and do not have coral reefs, the lessons learned from this example are equally applicable to coral reef MPAs.

Linking the data acquired from GIS mapping with extensive acoustic and video transects allowed an estimate of the broad- scale distribution of seabed habitat defined at several hierarchical levels and provided information on the cover of the dominant benthic species or assemblages.

In February 2004, the Kent Group MPA was implemented, covering waters out to the 3nmi limit and containing two areas defined as a Sanctuary Zone ('no take') and a Habitat Protection Zone ('restricted take'). In order to maximize the goals of the comprehensive, adequate and representative (CAR) network of MPA, it was important to include biological information at the largest scale practical in the planning process that which also will help in identifying and delegating the responsibilities and roles of the participating organizations and stakeholders.

In this study, the entire bioregion under Tasmanian jurisdiction was mapped which increased the likelihood of the MPA to achieve its objectives. The potential MPA locations were derived from the maps to maximize the habitat diversity while facilitating discussion of a range of possibilities and provide the capacity to incorporate socioeconomic considerations into the planning process.

Recommendation 2.4

Educate people about the zone boundaries and permitted uses, alongside training in ways to reduce human threats.

Case study 2.4a: Ko Chang Marine National Park – its design and the livelihood of the coastal communities. (Lunn, K.E. and P. Dearden. 2006. Fishers' needs in Marine Protected Area zoning: a case study in Thailand. Coastal Management, 34:183–198)

One of the main reasons why marine parks fail to be successful and achieve their management objectives is partly caused by inadequate consultation and participation of the local communities during planning and decision making. In all cases, MPAs are a common mechanism to accomplish conservation objectives while still allowing economic development.

The Ko Chang Marine National Park (MNP) consists of 47 islands that encompass 650km^2 area of land and sea. Although approximately 25% of the households in Ko Chang depended on fishing as their main source of income, and 95% of small scale fishers were reported working in the marine park - the general zonings in MNP are based mainly on the analysis of recreational patterns.

Interview responses from the head village suggested that 25-30% of the total number of households in the park were involved in fisheries as their main source of year-round employment- this could mean that a no-fishing zone in Ko Chang would render a significant amount of local communities jobless. Although presently there are restrictions on small scale fisheries within the park – none of the interviewed respondents were aware of such regulations and hence, small-scale fishers were the main consumptive users of the MNP during daylight hours.

Management of the Ko Chang MNP must balance the ultimate goals of the park between the areas that are fully protected and the areas open to sustainable small-scale fishing and tourism activities. This could result in conflicts between fishers and the other reef resource users. However, the resident fishers in Ko Chang have developed and maintained a good relationship with the park officials that contributed to a high level of public participation in the management of the MNP. The fishers' acceptance of and the compliance with the park's regulations will increase their involvement in the process and their increased understanding of the fisheries and conservation benefits of such areas.

Case study 2.4b: The Bunaken National Park's zonation and its local community. (Patlis, J.M. 2005. The role of law and legal institutions in determining the sustainability of integrated coastal management projects in Indonesia. Ocean and Coastal Management 48: 450-467)

The Bunaken Marine Park in Sulawesi, Indonesia was first implemented in 1991 under the Ministry of Forestry with two zones: a core conservation zone and a tourism zone. Following the implementation of a USAID-funded natural resources management regime (NRM 1), zonation was a poorly understood aspect of the local community members in the area of the BNP. The initial laws governing the BNP under NRM 1 were so complex as to cause confusion and ambiguity among the legal frameworks. In past surveys in the villages of Tiwoko, Nain and Rap Rap, the majority of villagers believed that there was no particular place in which activities were regulated, and most people did not recognize the conservation zone of BNP as a restricted zone. Only two communities, Manado Tua and Alungbanna, were aware of the conservation zone and some villagers acknowledged the tourism zone. Knowledge of the zonation scheme was found to be very localized and sporadic.

In 2004, a second USAID-funded management regime (NRM 2) was initiated, which gave greater autonomy to the regional and local government units. This included the establishment of a of the Bunaken National Park Management Board (*Dewan Pengelolaan*), comprised of representatives of both regional and central government agencies and community members from a variety of villages and livelihoods. The *Dewan* has been formally established by regional regulation. Since implementation of the NRM 2, regulatory practices relating to the BNP have greatly improved. Fishing permits issued by the regional fisheries department now include prohibition of activities within the Park waters. Awareness-building among the community members has also improved dramatically. The community members of the from the villages of Tiwoko, Nain, Bango, Alungbanna, Manado Tua and Rap Rap have a surprisingly strong understanding of the basic elements of the laws and institutions in place. Several respondents in Alungbanna mentioned that bottom trawling as a prohibited activity and virtually all recognized that fines or arrests were violations of the prohibitions.

Although most of the respondents are aware of the current zone boundaries and permitted uses, problems that breach such restrictions still persist. For example, In Tiwoko, almost all villagers said that mangroves were protected in the BNP. In Nain, however, where mangrove harvesting is an issue, none said mangroves were protected. Thus, continuing outreach efforts are needed to reach stakeholders, particularly informal processes targeted at smaller stakeholders and mass media campaigns to reach a wider audience.

Recommendation 2.5

Base local MPA management plans on locally perceived threats/issues and sound data on local resource status.

Case study 2.5a: The threats and exploitations in the Gulf of Aden. (Gladstone, W., N. Tawfik, D. Nasr, I. Andersen, C. Cheung, H. Drammeh, F. Krupp and S. Lintner. 1999. Sustainable use of renewable resources and conservation in the Red Sea and Gulf of Aden: issues, needs and strategies actions. Ocean and Coastal Management 42: 671-697)

The waters and resources of the Red Sea and Gulf of Aden are a source of economic, social and cultural prosperity and it is also a globally significant repository of marine and coastal biodiversity. However, a limited exchange between semi-enclosed seas nature of the Gulf of Aden and the oceans increases the chances of environmental damages from pollution events and activities that compromise the ecosystem integrity, like habitat destructions and unsustainable usage of resources.

It is crucial to design a management plan according to the local threats and the local resource status in the specific context of the Gulf of Aden. In some areas intertidal and nearshore subtidal habitats (including coral reefs) have been lost or degraded as a result of land-filling, reclamation and dredging for ports and industrial development. The various threats are categorized into comprehensive issues, symptoms/impacts, their causes, scale and severity. The underlying cause of the various threats is a lack of integrated planning and management, causing rapid and uncontrolled growth of unplanned settlements, expansions and development around the existing coastal towns. The solution to these issues lay in the framework for long term environmental management in the region, such as the gathering of management related information and data (especially fisheries data). The problem of some countries around the Gulf of Aden having limited ability to assess not only the impacts of human threats but also the state of their natural resources and environment must also be addressed.

Case study 2.5b: Tubbataha – creating a locally managed marine protected area in the middle of the Sulu Sea. (WWF Philippines. 2006. Tubbataha reefs: a marine protected area that works. WWF Philippines, Quezon City, Philippines. 22 pp.)

The Tubbataha Reefs are found at the very center of the Sulu Sea. They lie along the Cagayan Ridge, which traverses the Sulu Sea from the northeast, from the Sultana Shoal in Cagayancillo, to the southwest, to the San Miguel Islands of Tawi-Tawi. The nearest land mass of considerable size is mainland Palawan, with the capital of Puerto Princesa City lying 150 kilometers northwest of Tubbataha. The nearest islands are 130 kilometers in the other direction, northeast—Cagayancillo, the municipality where Tubbataha belongs.

At the start of the 1980's, fishers from Cagayancillo (called Cagayanons) started to perceive the pressure of overfishing in their immediate surroundings. Using traditional wooden sailboats called pangko, they sailed to Tubbataha to fish and gather shells, turtles, seabirds and their eggs. Trips to Tubbataha took anywhere from one week to a month, depending on the winds. There were times when three to five pangko would sail in fleets. The fishers would anchor their boats in the lagoons for safety and roam the reefs and islets freely, taking as much as their boats could carry, because they never knew when the conditions would be good enough to make another trip. In the minds of most Cagayanons, Tubbataha was a place of plenty.

Soon after, by the mid-1980s, the traditional pangko used by the Cagayanons was replaced by boats with motorized engines, making trips to Tubbataha faster and more frequent. Eventually, fishers from Cagayancillo were replaced by those coming from the neighboring Visayan provinces of Cebu and Iloilo. In turn, Visayan fishers were pushed to Tubbataha and other offshore reefs in the Sulu Sea by the deteriorating conditions of the coastal and marine environment in their own provinces. The arrival of fishers from the Visayas marked a turning point in the history of Tubbataha, because they introduced dynamite and cyanide fishing. Thus, they inflicted more damage in a few years than traditional Sulu fishers did over a thousand years. The Visayans resorted to the use of dynamite and cyanide to make their long-distance trips pay off, ensuring big hauls in a short period of time.

The increase in threats to Tubbataha culminated in its declaration as the Philippines' first national marine protected area in 1988, creating the need to set up a proper management system. This feat was far from easy, given the logistical difficulties posed by an offshore reef. What happened was akin to management by trial and error. A management body was created to take care of Tubbataha; when the designated body failed to deliver, the responsibility was passed on to another group. This went on for a decade. In retrospect, the success in managing Tubbataha can be attributed to a management structure that enabled local stakeholders to take the lead in decision making. Management changed hands, from national bodies based in far-away Manila to the provincial government, with participation from the national and municipal governments as well as private organizations. In 1995, a multi-sectoral Presidential Task Force was established to fill the management void. The Task Force was created to serve as the policy and program coordinating mechanism for the park. However, the fact that most of the members were still based in Manila once again became the bane of this management body. On top of that, the other

members were either too busy, or the park was not among their priorities. The original members of the Task Force never held a single meeting.

However, the Task Force did form an Executive Committee composed mostly of locally based institutions. Its purpose was to pursue conservation objectives on-site. The greatest problem was still the enforcement of park rules from the seat of management, which was Puerto Princesa. Because the Task Force was unable to fulfill its function, the late Governor Salvador Socrates initiated the establishment of the Tubbataha Protected Area Management Board (TPAMB), The TPAMB acts as the policy-making body responsible for the general administration and management of the park. Under the TPAMB is the Executive Committee (Execom), which reviews, evaluates and recommends actions on proposals, activities and plans.

The TPAMB has 17 members. Unlike previous management bodies, all member organizations have local offices based in Puerto Princesa and Cagayancillo, enabling the members to attend quarterly meetings. Decisions are made by consensus. If the TPAMB determines that additional technical information is required, the matter is delegated to the Execom for further investigation and deliberation. The Execom is composed of six TPAMB members, chosen because of their direct involvement in the implementation of specific management programs. In this way, those who are engaged in the day-to-day operations of the park are able to relay news and give feedback directly to park management, allowing for adaptive management.

In June 2001, through a project implemented by WWF-Philippines and co-funded by the Global Environment Facility –United Nations Development Programme (GEF-UNDP) and the David and Lucille Packard Foundation, the Tubbataha Management Office (TMO) was established. The TMO functions as the implementing arm of the TPAMB, overseeing the day-to-day operations of park management. The TMO is headed by a Park Manager. The rest of the staff was recruited from nearby areas, its three marine park rangers coming from Cagayancillo. The creation of the TMO provided a unit solely dedicated to implementing the park management plan and maintaining a presence in the park. It operates according to the park management plan, which translates into yearly work plans and budgets endorsed by the Execom and approved by the TPAMB. The TMO, in directly supervising park operations, has improved the administrative and financial management of the park. Its most important achievement was clarifying and enforcing park rules and regulations, including the conservation fee collection and permit system.

The most significant achievement of the Tubbataha Reefs as an MPA was not that it has become totally off-limits to fishing. Rather, it was the delivery of such dramatic results— 100% increase in fish biomass and 90% increase in income for the nearest fishing villages—over a relatively short period of time, and the recorded confirmation of such results, that make this a unique case.

Recommendation 2.6

Focus MPA management on the socio-cultural conditions and needs of communities. Incorporate formal workshops, participatory training exercises and community development to build trust and achieve stewardship of the MPA planning process.

Case study 2.6a: The marine resource management in Indonesia and its marginalized stakeholder: the local communities. (Fauzi, A. and E.A. Buchary. 2002. A socioeconomic perspective of environmental degradation at Kepulauan Seribu Marine National Park, Indonesia. Coastal Management, 30: 167-181)

The archipelago of Indonesia sits in the cradle of the richest area of marine diversity in the world, with more than 450 species of scleractinian corals and more than 2000 fish species recorded. Equal is the importance of these marine resources to the livelihood of the coastal people that makes the 60% of the total Indonesian population.

The recent 3 decades saw the emergence of the “New Order”, a political model that was driven by the growth-orientated macroeconomy which exerted great pressure on these marine resources. Conventional public resource management policy could not be developed due to the socioeconomic problems faced by the coastal communities, the complexity of policy implementation and institutional arrangements, together with the lack of monetary and technical resources from the government.

The Kepulauan Seribu Marine National Park’s (KSMNP) zoning plan that was drafted and gazetted in 1986 did not include the consultations of the local stakeholders – the resident islanders, the fishers and park users. Infringements such as illegal entry into the park and destructive fishing could have been reduced if the communities had been involved in the establishment and the management of the park from the beginning.

It was crucial to understand that the low level of formal education and lack of employment alternatives resulted in the islanders seeing entry to the fishery as their last resort to employment. Excluding the participation of the islanders in the management, planning and operation of the park has led to ill feeling and misunderstanding of the local government authority and mainland entrepreneurs who owns resorts in the park.

A few suggestions have been made to help alleviate the poverty and marginality constraints, that which includes the provision of a working community education or vocational facility for the islanders, encourage participation of islanders to create consensus building- to help create a climate in which the islanders may consider themselves as stewards of the park and will work cooperatively with park wardens and also providing opportunities for the KSMNP islanders to learn from other communities’ success stories such as the one in Blongko Marine Sanctuary in North Sulawesi.

Case study 2.6b: Designing MPAs based on local socioeconomic conditions in Papua New Guinea. (Cinner, J. 2007. Designing marine reserves to reflect local socioeconomic conditions: lessons from long-enduring customary management systems. Coral Reefs)

Coral reef conservation strategies such as marine protected areas have met limited success in many developing countries. Some researchers attribute part of these shortcomings to inadequate attention to the social context of conserving marine resources. To gain insights into applying Western conservation theory more successfully in the socioeconomic context of developing countries, this study examines how long-enduring, customary reef closures appear to reflect local socioeconomic conditions in two Papua New Guinean communities. Attributes of the customary management (including size, shape, permanence, and gear restrictions) are examined in relation to prevailing socioeconomic conditions (including resource users' ability to switch gears, fishing grounds, and occupations).

Customary closures in the two communities appear to reflect local socioeconomic circumstances in three ways. First, in situations where people can readily switch between occupations, full closures are acceptable with periodic harvests to benefit from the closure. In comparison, communities with high dependence on the marine resources are more conducive to employing strategies that restrict certain gear types while still allowing others. Second, where there is multiple clan and family spatial ownership of resources, the communities have one closure per clan/family; one large no-take area would have disproportionate effect on those compared to the rest of the community. In contrast, communities that have joint ownership can establish one large closure as long as there are other areas available to harvest. Third, historical and trade relationships with neighboring communities can influence regulations by creating the need for occasional harvests to provide fish for feasts. This study further demonstrates the importance of understanding the socioeconomic context of factors such as community governance and levels of dependence for the conservation of marine resources.

Recommendation 2.7

Translate the goals and objectives of the MPA such that they are understandable to the target audiences and the community context.

Case study 2.7: Communicating goals and objectives of MPA in the San Salvador Island
(Katon, B.M., R.S. Pomeroy, L. Garces and A.M. Salamanca. 1999. Fisheries Management of San Salvador Island Philippines: A Shared Responsibility. Society and Natural Resources, 12: 777-795)

Community-based coastal resource management (CBCRM) projects have been implemented in the Philippines since the early 1980's. The San Salvador Island case illustrates that the CBCRM can serve as a route to sustainable, equitable and efficient coastal resource management and also to comanagement. Co-management refers to the sharing of responsibility and/or authority between government and community of local users to manage a resource. However, purely community-level management can be difficult to implement in the complexity of multiple stakeholders. Hence it is crucial to clearly communicate the goals and objectives of the MPA to all stakeholders, especially the local communities that would traditionally be the direct resource users.

By getting the fishers and local resource users involved in enforcement and in developing rules and policies, it will provide also ownership and accountability of decisions and actions. To aid this, intensive information campaigns has helped the residents to realize the consequences of unsustainable uses and heightened their concern over protecting the resources that ensures their livelihood and survival.

In summary, clarifying the objectives of the MPA to the stakeholders by clearly communicating approaches to a well-defined set of issues can help steer the direction of comanagement. There is no doubt that when resource users and stakeholders have a good grasp of the rationale of managing the resource, with the understanding of the short-term and long-term objectives to sustain the comanagement.

Recommendation 2.8

Create a forum for stakeholder interaction, query, and debate to provide opportunities for collaboration and mediation within the context of social interactions and conflicts.

Case study 2.8: The cooperation between multiple stakeholders of the MPA in Australia. (Baelde, P. 2005. Interactions between the implementation of marine protected areas and right-based fisheries management in Australia. Fisheries Management and Ecology 12: 9-18)

It is widely acknowledged that effective management of natural resources requires the participation of those directly affected by management measures. In Australia, the major challenges for the governments in the implementation of MPA are the poor cooperation between fisheries and conservation agencies, principle inconsistencies between allocations of fishing rights by fisheries agencies and loss of these rights through MPA declaration; re-allocation of resources between user groups through spatial zoning; lack of fisheries expertise in conservation planning and inappropriate single- species/ single- issue approach to fishery management.

Fisheries agencies have long used area closures as part of fisheries management but the management principles underlying fisheries and conservation agencies' use of spatial closures differ significantly and at times, conflict with each other. Although there is a high likelihood that fisheries and conservation agencies will conduct two separate MPA planning processes due to the operation of different legislations, it is a responsibility of both agencies to develop well-thought-through and well structured cooperation protocols to ensure a more effective management of marine resources. Today's trend that inclines to paying less emphasis to data collection or sharing and adaptive management - could prove to be detrimental eventually, turning the potential merits of ecosystem- based spatial closures into management failures.

Recommendation 2.9

Involve marginalized user groups (gender and ethnic equality) and functional community leaders to promote good will, improve project management, and ensure equitable distribution of benefits.

Case study 2.9a: The sustainability of ICM projects in the Philippines. (Thiele, M.T., R.B. Pollnac and P. Christie. 2005. Relationships between coastal tourism and ICM sustainability in the central Visayas region of the Philippines. Ocean and Coastal Management 48: 378-392)

Coastal resource management (CRM) has a long history in the Philippines. The Central Visayas Regional Project (CVRP) was one of the earliest and largest community- based integrated coastal management (ICM) projects in the Philippines. The objectives of the CVRP placed a strong emphasis on community organizing. Trainings were conducted to help participating families to organize themselves into fishermen's associations and federations, many of which are still in existence. Coastal tourism is traditionally considered to benefit developing economies and especially local communities through local revenue stimulation. It is considered an opportunity to promote economic development with minimal negative impact with responsible development. However, the analysis of the research done to evaluate the coastal tourism and ICM sustainably as perceived by the local communities revealed mixed impacts from tourism by the nearby communities. Negative impacts could be related to social stratification within the communities where tourism exists. It is typical that the immediate area around the tourist resorts is most well-to–do and pristine, contrasting with the areas further from the resorts that are poverty stricken and receive few benefits of the tourism industry. This is common where tourism resorts deny community access to its designated beachfront sanctuary areas, where it could have previously been part of the local fishing grounds.

Another analysis revealed that the village meeting attendance is lower when tourist businesses are involved in ICM activities, perhaps bearing the perception that the money-making resort owners have more weight in these community meetings. This situation could most likely create a disgruntled surrounding community- one that is unlikely to be supportive of additional ICM activities. ICM practitioners should seek more balanced and equitable co-management of resources and the dynamics of this relationship warrant further investigation. Furthermore, ICM activities like marine sanctuaries should hold all stakeholders accountable to the same standards and not allow unfair exclusions or benefits only to the tourism industry.

Case study 2.9b: Involving poor fisherfolk in MPA management in the Philippines. (Majanen, T. 2007. Resource use conflicts in Mabini and Tingloy, the Philippines. Marine Policy 31: 480–487)

The Philippines is well known for its rich marine biodiversity but its large and rapidly growing coastal population has caused 98% of its coral reefs to be under medium or high threat. Mabini and Tingloy, located in the province of Batangas, are neighboring municipalities that emerges as a recreational dive destination in the 1970's. Both have traditionally been central to the local economy but today, multiple stakeholders have showed interests in the reefs and several conflicts are marked by clear power imbalances. This paper strives to address the twin challenges of biodiversity conservation and economic development. The conflict between conservation and

fishing was the most pronounced conflict perceived by residents of Mabini- Tingloy. It is crucial to recognize that although tourism and conservation conflicts are not mutually inclusive, one conflict should not be discussed outside the context of the other.

Imbalanced power relationships and unfair political alliances are not uncommon between MPA stakeholders. Another major conflict arises between the local people and the tourism industry is the lack of substantial direct economic benefits provided by the tourism industry on terms of livelihood. However, a research in the Philippines shows that job satisfaction among the fishers is generally high and hence they would prefer their current livelihood even if they have an opportunity in the tourism for them.

Economic benefits of conservation tend to be limited on a local scale; increases slightly on a regional scale and become substantial over the global scale. It is no wonder why many of the local fishers feel marginalized by conservation and that sanctuaries have negatively impacted their livelihood. Thus, protected areas should ideally pay for themselves through donor fundings or by generation of revenues to avoid conflict. Local communities' economic losses should be compensated either by cash, goods or services. Providing substitution for specific resources to which its access has been denied and providing alternative source of income is critical. Sanctuary management and user rights need urgent clarification, where sanctuary ordinances should be respected and equally enforced. If local communities agree with the decision to allow diving in the sanctuary, the ordinances should be amended clearly to state explicitly which activities are allowed and the ordinances should be enforced consistently. Communication and education programs are needed to clarify the objectives of conservation and the impacts that they will have on the livelihood of fishers and other residents.

Recommendation 2.10

While permanent reserves are more effective, rotational or seasonal closures or regulations other than complete closures are often more accepted, have less immediate social impacts and are easier to monitor and enforce.

Case Study 2.10a – Effectiveness of rotational vs. permanent closures on reef fish biomass in Hawaii. (Williams, I.D., Walsh, W.J., Miyasaka, A, and A.M. Friedlander. 2006. Effects of rotational closure on coral reef fishes in Waikiki-Diamond Head Fishery Management Area, Oahu, Hawaii. Marine Ecology Progress Series 310: 139-149)

No-take marine reserves can be very effective in conserving biodiversity,: well-protected reserves generally have larger and more abundant fishes, particularly of species targeted by fisheries, than comparable unprotected areas or in comparison to populations prior to closure (Polunin & Roberts 1993, Edgar & Barrett 1999, McClanahan & Arthur 2001, Russ & Alcala 2003). However, prohibiting fishing will almost always result in some cost or loss of utility to excluded user groups, including both commercial and recreational fishers (Badalamenti et al. 2000, Sladek Nowlis & Friedlander 2005). Over time, spillover of adult fishes or export of larvae from no-take reserves may lead to net benefits to fishers in connected areas (McClanahan & Mangi 2000, Roberts et al.

2001, Russ et al. 2003, 2004, Sladek Nowlis & Friedlander 2005). However, the magnitude of such benefits is uncertain and protection generally needs to be effective for an extended period for a reserve to be an effective fishery management tool (Russ & Alcala 1999.

One alternative to permanent closures is to manage an area by a rotational strategy, i.e. alternately opening and closing an area to fishing. The rationale is that fish stocks would recover sufficiently during periods of closure for them to be better able to sustain fishing during open periods. Such a strategy might reach some conservation goals while mitigating the drawbacks associated with permanent closure.

Using data taken from the state of Hawaii's long-term reef monitoring program, Williams et al. (2006) assessed the effects of more than 2 decades of rotational management on fish stocks at the Waikiki-Diamond Head Fishery Management Area (FMA) on Oahu, Hawaii. Fish biomass tended to increase during the 1 to 2 yr closure periods, but the scale of these increases was insufficient to compensate for declines during open periods. The net effect was that, between 1978 and 2002, total biomass declined by 66%. In addition large individuals (>40 cm) of target species: acanthurids, scarids and mullids, virtually disappeared. Such fishes, although initially common, were rarely recorded in surveys after 1990. In 1988, a portion of the FMA was converted into the permanently closed Waikiki Marine Life Conservation District (MLCD). Assessment of the relative effectiveness of permanent and rotational closure was complicated by declines in habitat quality, particularly within the MLCD, caused by overgrowth of much of the reef by the invasive macroalgae *Gracilaria salicornia*, which began in the early 1990s. However, the initial effect of full closure was a reversal of the previous downward trend in fish biomass, and, even in the post habitat-decline period, biomass of target species was nearly twice as high within the MLCD as in the FMA. Additionally, there have been no declines or even downward trends in maximum size of target families in the MLCD.

In summary, despite short-term boosts to fish stocks and possibly also to fishers during or immediately after 1 to 2 yr periods of closure, the longer-term consequences of rotational closures of the Waikiki FMA have been steep declines in the biomass of target fishes, together with the virtual disappearance of larger individuals of these groups. Thus, rotational management has not been an effective means of conserving fish stocks or revitalizing public fishing over the longer term.

Case study 2.10b: Comparison of permanent MPAs to other forms of coral reef management. (McClanahan, T., Marnane, M.J., Cinner, J.E. and W.A. Kiene. 2006. A comparison of Marine Protected Areas and alternative approaches to coral-reef management. Current Biology 16: 1408-1413)

Marine protected areas (MPAs) have been widely adopted as the leading tool for coral-reef conservation, but resource users seldom accept them (Christie 2004, McClanahan et al. 2005b) and many have failed to produce tangible conservation benefits (McClanahan 1999). Few studies have objectively and simultaneously examined the types of MPAs that are most effective in conserving reef resources and the socioeconomic factors responsible for effective conservation

(Pomeroy et al. 1997, Pollnac et al. 2001, Cinner 2005). We simultaneously explored measures of reef and socioeconomic conservation success at four national parks, four co-managed reserves, and three traditionally managed areas in Indonesia and Papua New Guinea. Underwater visual censuses of key ecological indicators (McClanahan 1994, McClanahan and Shafir 1990) revealed that the average size and biomass of fishes were higher in all areas under traditional management and at one co-managed reserve when compared to nearby unmanaged areas. Socioeconomic assessments (Cinner 2005, Cinner et al. 2005a, Cinner and McClanahan 2006) revealed that these MPA effects were positively related to compliance with regulations, visibility of the reserve, and length of time the management had been in place. Conservation effects were negatively related to market integration, wealth, and village population size. In cases where the resources for enforcement are lacking, management regimes that are designed to meet community goals can achieve greater compliance and subsequent conservation success than regimes designed primarily for biodiversity conservation.

All effective sites were able to exclude ‘‘outsiders’’ at a relatively low cost because the managed areas were located near the village. The effective traditional sites also had strong customary marine tenure institutions, which prohibited non-owners from accessing reef resources (Cinner 2005, Cinner et al. 2005a,b). Interestingly, observed compliance was highest in the three self-governing traditionally managed areas, which did not have regular enforcement. This suggests that the effectiveness of these sites in conserving reef resources resulted from intrinsic motivations to act collectively and comply with regulations (Colding and Folke 2001, Sutinen and Kuperan 1999).

Social influences promoting collective action and the perceived justness and legitimacy of regulations (Berkes et al. 2000) may be particularly high in traditional sites because they reflected local understandings of human-environment interactions, were an integral part of local cultures and traditions, and provided the villages with tangible benefits. For example, communities periodically fished these areas and perceived direct benefits of the management system; thus, these systems met more individual and community goals than permanent closures. In addition, most village members were regularly reminded of the closures through participation in the traditions and feasts (Aswani 1999). In all traditionally managed sites, village leaders had some control over the timing and scale of harvesting within the protected area. Leaders also had the ability to develop rules that were congruent to local ecological and social conditions and also to adapt management to observed changes in ecosystem dynamics, socioeconomic influences, and evasion of governance rules (Aswani 2002, Berkes 1989, Cinner et al. 2005b). For example, in Muluk, Indonesia, clan leaders instituted a temporary closure when they observed a decrease in fish abundance (Cinner et al. 2005b). The size of the closure, length of time, and sanctions for violations could vary to meet the changing needs of the village and ecosystem.

The ability of periodic closures to enhance fish stocks and subsequent fishery yields likelydepends upon the intensity of fishing effort during open periods, in addition to the life history characteristics of the targeted species. In the case of one of these sites, Ahus, periodic harvesting was carried out on only one day every 6–12 months and removed only around 5% of the available biomass on each occasion (Cinner et al. 2005a).

However, if similar management methods were to be employed elsewhere, especially in areas of intense fishing pressure, the extent and type of harvesting to occur in managed areas would have to be carefully monitored and regulated, because differences in fishing effort, gear type, and frequency of harvest can all impact the outcomes and management benefits of rotational closures.

Issue 3: Economic Objectives and Impacts

Every so often, the designing of a marine protected area would tend to overemphasize and underestimate the weight of the economic aspects when designing or implementing a marine park area project. Whether it is the capacity of input of receiving financial aid to run the project or the revenue that is potentially generated from the project; most projects somehow experience the economical prospects of a marine park area that is distributed unfairly. The economic gains from the coastal resources should be adequately informed and distributed to all stakeholders, especially the local communities – lest they undermine the revenue- generating mechanism from the project activities and render more support to ensure its sustainability.

Recommendation 3.1

Clearly identify and communicate economic and other benefits of MPAs to maintain stakeholder interests and manage expectations.

Case study 3.1a: Perception, understanding and realistic expectations of stakeholders in Philippines MPAs. (Pomeroy, R.S., E.G. Oracion, R.B. Pollnac and D.A. Caballes. 2005. Perceived economic factors influencing the sustainability of integrated coastal management projects in the Philippines. Ocean and Coastal Management 48: 360-377)

Although integrated coastal management (ICM) has a long history in Philippines, most of the efforts have not been sustainable. This has become a pressing issue that the government of Philippines has to address. One of the main factors influencing the sustainability of ICM is the economic aspect in the sense of the level of economic benefits received and how equitably the economic benefits are distributed in the community.

It is crucial to understand that if the local residents or the stakeholders think that the ICM project does not address the local concerns or have any positive impact on their interests or well- being, it will be unlikely to expect solid support or involvement in the project activities. Thus, all affected parties should be identified and proper communication for understanding the perceptions of the present economical impacts of the project should be sent across. Through this, a sense of ‘ownership’ would be imparted to the stakeholders and local community members besides yielding a greater probability that the aspects of this project will fit the needs of the community members.

For instance, marine reserves in Bais Bay established under a project called CVRP have increased the fish catch, and subsequently raised income while being sustainable. Project activities should raise income and provide new occupations of the participants to be sustainable. As such, resource management activities that results in improved resource conditions and raises income are important to maintain interests of the participants and also the non- participants resulting from this project.

Case study 3.1b: Economics of potential marine tourism in Bolinao, Philippines (Ahmed, M., G.M. Umali, C.K. Chong, M.F. Rull and M.C. Garcia. 2007. Valuing recreational and conservation benefits of coral reefs — the case of Bolinao, Philippines. Ocean & Coastal Management 50: 103–118)

Located on the western coast of Luzon Island, the region of Bolinao covers about 23,320 ha – of which 8,000 ha are coral reefs. Its main source of income includes farming, fishing, small scale and cottage industries and tourism, which is still at an early stage. Apart from tourist accommodation facilities, there are no commercial establishments directly related to marine tourism. Hence, the Bolinao reefs represent an ideal study site on economic valuation in view of its tourism potential and its established reputation as important fisheries location. An economic valuation study was conducted to address this issue and to formulate a tourism regulatory committee to monitor the level of utilization activities in order to provide a sound economic rationale for their management.

One of the findings from the study was that fewer visits are made to Bolinao as income increases. This trend may be largely influenced by the perception that the Bolinao reef is considered to be inferior to other coral reef sites in Philippines; especially those with reefs that are in better condition and more up-scale tourism facilities, such as Anilao in Batangas or Puerto Galera in Mindoro. In addition, resource managers can also expect reduced visitor participation as user fees increase. While the higher income respondents do place premiums on environmental improvements, the lower income counterparts may face financial constraints that supersede whatever personal value they place on natural resource and its environmental services.

Recommendation 3.2

Evaluate costs and benefits of private sector involvement early in the MPA development to assure buy-in and long-term engagement.

Case study 3.2a: Public-private partnership (PPP) – gaining popularity in Philippines ICM. (Milne, N. and P. Christie. 2005. Financing integrated coastal management: experiences in Mabini and Tingloy, Batangas, Philippines. Ocean and Coastal Management 48: 427-449)

The sustainability of the Integrated Coastal Management (ICM) process depends on the ability of the ICM policies, institutions, activities and practitioners to support coastal and marine resource use and conservation goals beyond donor- assisted project support. Currently the success of most ICM projects in the Philippines depends on the ability of municipalities to secure adequate financial and technical support for coastal management initiatives.

The Haribon Foundation, a private sector – initiated the first ICM projects in Mabini in 1988, working with fishermen and later with resort owners to establish a marine reserve and three marine sanctuaries. The World Wild Fund for Nature (WWF-Philippines), initiated the second major ICM project in 1997.

Public-private partnerships (PPP), an affiliation between the public and private sector for the purpose of delivering a project or service traditionally provided by the public sector, are becoming more popular as a means to finance and implement ICM activities. Early participation of the private sector in the planning and design of the ICM and MPA would ensure the private sector's continuous support, involvement and investment in the long run.

Case study 3.2b: An example of a privately-operated MPA in East Africa – Chumbe Island (Riedmiller, S. 2000. Private Sector Managment of Marine Protected Areas: The Chumbe Island Case, In: Cesar H.S.J. (ed.), Collected Essays on the Economics of Coral Reefs, CORDIO, SIDA)

Chumbe Island Coral Park Ltd (CHICOP) was established in 1991 and was probably the first fully functioning Marine Protected Area (MPA) in Tanzania. Investment and fisheries legislation and the institutional environment of Zanzibar (Tanzania) made the park possible, but required higher investment than anticipated. Management costs are funded through ecotourism and are much lower than donor-funded government-run park budgets. In particular, training and employment of local fishermen as park rangers by volunteers proved cost effective and facilitated direct partnership with local fishing communities.

Non-extractive and non-destructive use through ecotourism adds economic value to coral reefs and creates incentives for effective and sustainable conservation. The private sector can play a decisive role in establishing and managing no take ecological marine reserves that support biodiversity and fisheries. Private sector cost control and income generation create better prospects for sustainability. To encourage private investment in partnerships for conservation, a conducive investment climate, security of tenure and contractual security are essential. International insurance schemes for MPAs could help buffer risks of volatile tourism markets.

In donor-dependent countries in the developing world effective conservation area management may require a change of paradigms. It must be acknowledged that people using the same marine area, fishers, tourism operators, seaweed farmers, respond to economic incentives derived from that particular area, irrespective whether they belong to the formal or the informal economy. Therefore, the common dichotomy between the 'local community' and the 'private sector' is not helpful for identifying local stakeholders. In contrast, government and donor agencies have primarily institutional interests that provide few direct incentives for effective conservation or management of a particular area. Commercial risks of the private sector need to be acknowledged and competition from over-funded donor projects avoided. Where governance is problematic, environmental certification is more effective for responsible management than state regulations. Finally, international donor support would have more impact when seeking partnerships with direct resource users from both the informal and formal private sectors, including support to privately managed MPAs.

Recommendation 3.3

MPAs will have higher compliance and be more effective at conserving resources if they are easily visible to the community, and compliance is likely to increase the longer the MPA remains enforced.

Case study 3.3: Providing support for the Sumilon and Apo Marine Reserves, Philippines. (Russ, G.R. and A.C. Alcala. 1999. Management histories of Sumilon and Apo Marine Reserves, Philippines and their influence on national marine resource policy. Coral Reefs 18: 307-319)

Out of 300 designated and 600 proposed marine protected areas listed in the UNEP/IUCN coral reef inventory (1998), only a handful are being managed with the support of the local people who depend on the resources. The rest are regarded as 'legal decrees' or 'paper parks', those that exist only in legislation but have no effective enforcement or management in place.

In 1976, the Silliman University initiated a marine conservation and education program at Apo Island. A concrete meeting centre for the Marine Management Committee was built with the support of the university and Earthwatch expedition. The planning, construction and frequent use of this building have been critical factors in maintaining the enthusiasm of the residents for the marine reserve concept.

This has provided the local community with a useful venue for meetings of the Marine Management Committee and a location to display educational materials about marine conservation and the Apo reserve. From this scenario, it is evident that the Apo Island marine reserve has strong local support and a good degree of community compliance with management regulations and continues enforcement.

Recommendation 3.4

Where fishers or other resource users are likely to be displaced, provide realistic, long-term options for alternative livelihoods (e.g. ecotourism, catch-and-release sport fishing, seaweed farming, etc.).

Case study 3.4a: Seaweed farming and mariculture: the alternative to fishing in Malalison Islands, Philippines. (Amar, E.C., R.M.T. Cheong and M.V.T. Cheong. 1995. Small-scale fisheries of coral reefs and the need for community-based resource management in Malalison Islands, Philippines. Fisheries Research 25: 267-277)

In the Philippines coral reefs are used as traditional fishing areas by about 700 000 small-scale fishers who provide 55% of the nation's food fish, and one such place is the Malalison Island. The only community on the islands, Barangay Malalison had a total population of 431 in about 80 fishing households in 1981 and 466 people in 1993. The fish catches are marketed daily in Culasi.

The intense fishing effort in Malalison which reaches 34 fishers per km² of reef is much higher compared to other tropical countries having about 10 fishers per km^2. However the low catch per unit effort in Malalison suggested that the fishery is not in good condition. Hence in this case, the intensive multi-species fishing has significantly decreased the catch and degraded the resource base.

Up to 1996, Malalison fishers were totally dependent on reef fisheries without any viable alternatives. The inadequate catch has further compelled them to use destructive fishing methods such as dynamite and cyanide. Several mitigation and management plans have been proposed to counter the problem of the "Malthusian Overfishing". Apart from effective enforcement of existing of existing laws, protective management (resources and sanctuaries) and sea ranching are management tools that have proven to be effective. For example, the Community Fishery Resource Management Project in Malalison Island has implement management tools with also small scale and land- based enterprises and the mariculture of the seaweed *Kappaphycus alvarezii.*

Case study 3.4b: Seaweed farming as an alternative livelihood for displaced fishers in Indonesia and the Philippines. (Sievanena, L., B. Crawford, R. Pollnacc, C. Lowe. 2005. Weeding through assumptions of livelihood approaches in ICM: Seaweed farming in the Philippines and Indonesia. Ocean & Coastal Management 48: 297–313)

Although alternative livelihood approaches such as seaweed farming is a commonly adopted policy in the Integrated Coastal Management (ICM) objectives, very few studies have examined the extent to which the adaptation of seaweed farming has affected other household sources of income or the impact on fishing effort and implications for conserving fish habitat. Ideally, seaweed farming is introduced to raise the socioeconomic status of the coastal communities as well as to provide an alternative income for fishers – in hope to divert fishers that uses destructive fishing techniques to a more profitable and sustainable income. However, the claim of seaweed farming in reducing fishing pressure or reducing destructive fishing practices has not been critically researched.

In the Bohol Province of Philippines and in Bentenan, Tumbak area of Indonesia, the relative importance of seaweed farming has increased significantly over the past 2 decades and for the most part, it was due to the increase in prices paid for the product on the international market. It is rather unlikely that subsistence fishing will decrease upon inception of seaweed farming in a population of Indonesia and Philippines where half of it depends on the sea for their subsistence needs. This is the expected outcome unless alternative livelihood projects are combined with controls to prevent increased fishing effort and new entrants into the fishery and dietary shift away from fish as a primary protein source in the diet. Most of them continued to fish at the same level stated that fishing resulted in daily income that provides food for their family while the income from seaweed farming was received only after the harvest several months after planting.

The village head in Bentenan also stated that people are unwilling to plant again after a failure because seaweed growth was not as high as previous yields after its market price drops. Herbivorous fishes such like the rabbit fish will consume the crops of those who started in small amounts but now mainly using less profitable seaweed. However, multiplicity of occupational sources is common in many coastal communities in Southeast Asia, it is common for households to fall back on other forms of income when one fails- which is an effective economic strategy. The decline in seaweed farming has been commensurate with the increase in fishing effort, which later will lead to overfishing and the subsequently the declines in income and employment if this issue is not backed up by larger resource management strategies.

Issue 4: Governance of MPAs

Several common challenges often plague the designing, development and implementation of a legislative framework for coastal and coral reef managements. Most conflicts could arise between law and regulations, policy and enforcement, agencies and stakeholders- all due to the differences of their sectoral focus. Although it may be a difficult process to achieve an effective framework to manage the coastal and reef resources, the success is also largely determined by the commitment of each sectors, stakeholders and institutional arrangements to be collaboratively involved to achieve a sustainable management.

Recommendation 4.1

Explore bottom-up and co-management approaches, recognizing that varying management structures and strategies improves MPA effectiveness.

Case study 4.1a: Development of co-management and community management of marine resources in the Philippines. (Balgos, M.C. 2005. Integrated coastal management and marine protected areas in the Philippines: Concurrent developments. Ocean & Coastal Management 48: 972–995)

The livelihood, food security and the economics of communities in the Philippines are largely dependent on coastal resources and fisheries but the establishment of marine protected areas (MPA) begun only in 1970. The establishment of the first MPA occurred when marine scientists and resource managers recognized the signs of depletion and degradation of marine resources, especially the coral reefs.

Throughout the 3 decades of Philippines MPA establishment, lessons learned were integrated into the design of Integrated Coastal Management (ICM) programs. Since both MPAs and ICM basically adopted the community-based approach, similar management principles developed concurrently for both. Central to both MPAs and ICM is the empowering of coastal communities politically and economically so they can assert and gain rightful access and management control over their coastal resources. In addition, equity in access to resources for disadvantaged groups and the respect for traditional knowledge are also important.

Environmental and natural resources governance in the Philippines was highly centralized before 1991. Today, revenue sharing formulas has put together a greater share of the national budget into the hands of the provincial administration under the governors and within the municipalities – where they can now establish marine sanctuaries without the need for central government approvals. Within this decentralized context, community-based marine sanctuary concept has flourished and the Barangay and Municipal Fisheries and Aquatic Resources Management Councils (FARMCs) were formed to institutionalize resources management at the local level.

To ensure the resilience of the MPA after the initial funding is exhausted; the MPA may continue to be funded under the local government internal revenue allocation. It can also be supported by income from the collection of user fees from divers and other tourists who visit the marine sanctuary. Aside from funding, the MPA project should have an evaluation at the beginning stage to verify whether all aspects of the project are logically connected and to determine if there are sufficient resources to accomplish the goals. Also important is the experience and skill levels of community organizers or on-site field-worker in the establishment and implementation of the community- based ICM and MPA program; and the continuous learning from the private sector through public- private partnerships in order to make alternative livelihood projects work. Lastly, political reasons are also to be considered among the criteria used in evaluating effectiveness and justifying choices among alternative management options – where players must strive to understand and to look outside their interests for a rationale for action.

Case study 4.1b: Mixed responses to the no-take MPA in the Exumas Island, Bahamas. (Stoffle, R. and J. Minnis. 2007. Marine protected areas and the coral reefs of traditional settlements in the Exumas, Bahamas. Coral Reefs 26, 4: 1023-1032)

The Exumas Islands in the central of Bahamas is home to traditional coastal communities and there are about 20 small settlements located in the islands and cays. Recently, three large No-take MPAs were proposed by the Bahamian government. Two northern communities responded strongly against the MPA, another two central communities were neutral and the two southern communities in contrast, were strongly positive about the MPA. It was generally assumed that if a nearby community is the primary user of a proposed MPA, the people will recognize the positive impacts of the MPA and the community in turn will help regulate the MPA. However with the mixed responses from the different communities of the Exuma Islands, it was important then to understand what causes the disagreements in order to ensure that the MPA is effectively meeting its objectives.

It was found that the northern communities were strongly against the MPA because it eliminated all their fishing, especially in their leeward cays. Meanwhile the central communities were neutral about the proposed MPA because they thought it would eliminate fishing by outsiders and permit them instead to manage and regulate the MPA for wages. However, their opinions changed to negative when they realized that the MPA would eliminate their subsistence fishing. The southern communities were positive about the MPA because they thought it would protect their spawning aggregations from outside commercial fishers and also because they rarely fish there.

All three MPA proposals reduced compliance, because of their top-down design and management, reduced community resilience because they restricted subsistence fishing in most areas, and were also a threat to the identity of the local communities because they would stop most community members from engaging in traditional subsistence fishing they had practiced for generations, forcing people who had eaten fresh seafood all their lives to purchase frozen fish.

Recommendation 4.2

MPA regulations need to be pragmatic and address root causes but not be unrealistic in the ability of people to change their behavior.

Case study 4.2: Developing MPAs for subsistence fishing in Samoa (Zann, L.P. 1999. A new (old) approach to inshore resources management in Samoa. Ocean and Coastal Management 42: 569-590)

The people of the South Pacific islands have traditionally relied on the seas for most of their dietary protein but the increasing populations and development in many of its nations have placed heavy pressures on coastal environments and on inshore fisheries. Samoa is one of the least developed nations and is lacking in exploitable natural resource and most of the population lives at a subsistence level. The Samoans are a Polynesian people who have maintained a traditional way-of-life as a subsistence farmer/fisherfolk.

The development of a suitable co-management model has assisted the villages to manage their own resources by determining the status of their own fisheries and develop and plan actions that will allow reefs and fisheries to recover. This is in contrast to typically passing national laws without recognizing the real solutions to the problem falls in the hands of the village people and their councils- which some laws would require them to change the way they have traditionally lived their lives.

It was important to identify the important role that subsistence fishing is crucial for the subsistence of the majority of Samoan households. Samoan local communities have a long tradition of environmental conservation and communally own land and sea resources – hence it is most appropriate to devolve responsibilities in the natural resource management back to those communities and not to expect them to change their behavior merely for the sake of technical proposals presented in the management papers.

Recommendation 4.3

Zoning requires knowledge gained through a participatory process and that is well integrated with tools such as participatory mapping and GIS.

Case study 4.3: Habitat mapping in Western Samoa and Fiji in MPA designs. (Knight, D., E. LeDrew and H. Holden. 1997. Mapping submerged corals in Fiji from remote sensing and in site measurements: applications for integrated coastal management. Ocean and Coastal Management, 34: 153-170)

The increasing scope and magnitude of impacts and environmental change in coastal environments, particularly coral reefs, demand the development of new approaches to delineate features, monitor change and manage resources more effectively. Perhaps one of the greatest impediments to the implementation of ICM plans is the requirement for accurate and replicable scientific data sets that can be used as a basis for informed decision making.

The Pacific Island leaders have organized a series of workshops in Western Samoa and Fiji (1994) to discuss the concerns and options related to impacts of coastal erosion. Regional experts agreed that the highest priority should be rectifying deficiencies in mapping and data collection for coastal zones. Although Fiji has the second longest stretch of coral reefs in the world, there has been little systematic mapping of the coastal environment.

The remote sensing data and mapping procedures are indispensible tools that can be integrated with other databases into a Geographical Information System (GIS) to highlight other environmental, socio-economic and cultural attributes of the coastal areas. This integrated data would be an important information source that will facilitate better awareness and support for zoning and developing sustainable development strategies.

Since coastal ecosystems are highly interdependent, the procedure could be expanded to map and assess the spectral response of other associated systems – integrating marine and land process features to assist planners and managers in identifying the areas to gazette for protection, assessing the environmental impacts and identifying other areas requiring restoration.

Recommendation 4.4

Policies that include more than one jurisdiction will require time to integrate and may often need to be agreed on prior to implementation.

Case study 4.4a: The integration of policies for holistic management capacity of MPA. (Osborn, D. and A. Datta. 2006. Institutional and policy cocktails for protecting coastal and marine environments from land-based sources of pollution. Ocean and Coastal Management 49: 576-596)

Instruments individually have their strengths and weaknesses, as do government institutions and public-private relations. No single institution has the flexibility or resilience needed to successfully address all environmental problems. Hence, policy “cocktails” that incorporate institutional combinations are adopted to achieve management goals and objectives.

Institutional and policy combinations may be inherently complementary, neutralizing, redundant or counterproductive. Occasionally they may even be antagonistic and dysfunctional as the result of the context in which they are applied. Target sectors and coastal populations may have different motives in responding to the same policy instrument and may thus respond differently.

It is also important to integrate the policy mixes with the elements of the broader policy environment so that all jurisdictions involved could reach agreement– approaching also the ethical, information, economic, moral, administrative and enforcement factors that affect not only behavior but also the law. The objective of the policy integration should be ‘seamless regulation’ and broad-based economic incentives that encourage rather than diminish inter-sectoral cooperation.

Case study 4.4b. Transboundary management of the Sulu-Sulawesi Seascape. (Miclat, E.F.B., Ingles, J.A. and J.N.B. Dumaup. 2006. Planning across boundaries for the conservation of the Sulu-Sulawesi Marine Ecoregion. Ocean & Coastal Management 49: 597–609)

The Sulu-Sulawesi Marine Ecoregion (SSME) is a highly biodiverse marine ecoregion shared by Indonesia, Malaysia and Philippines. An integral part of the Coral Triangle, the SSME is characterized by a rich abundance and variety of habitat and productive coastal ecosystems. It is economically significant to all 3 countries, as a major source of live reef food fish with 2.3 million tons in capture fisheries alone. However the increasingly unsustainable use of the SSME's marine and coastal resources has resulted in the degradation of its environment. This, in addition to the poverty and ever-increasing human population presents a bleak prospect for the reefs and those people who depend on it. The ecosystem approach concept launched by the World Wide Fund (WWF) aims to conserve and where possible restore the maximum range of biodiversity over large spatial scales. Stakeholders are the key to the success in conserving the SSME, as they hold an understanding and knowledge gained through generations that can make them dedicated and effective stewards of the resources.

Several key lessons were extracted from this large-scale and multi-lateral conservation planning effort. Ecoregional conservation planning should involve the stakeholders early in the planning process, at all levels. Also, it is also crucial for governments to appreciate the significance and the urgency of large scale conservation efforts. Because ecoregional conservation is a technical-based initiative that spans national and international boundaries, the processes involved should be politically neutral to enable the multi-national initiative to advance without being hindered by other political agendas. Lastly, another important component of this multi-national partnership is the credibility of an NGO-partner that provides the momentum to this initiative.

Recommendation 4.5

Rapid and fair enforcement is essential to achieve continued support, faith, and compliance in MPA management.

Case study 4.5: Leveling the laws and enforcement on natural resource management in Indonesia (Dirhamsyah, D. 2006. Indonesian legislative framework for coastal resources management: A critical review and recommendation. Ocean and Coastal Management 49: 68-92)

The complicated and inappropriate legal framework currently in place in Indonesia has contributed to serious degradation of coastal and marine resources. This deterioration has been worsened by the lack of a national marine policy and severe weakness in law enforcement, especially fisheries laws and regulations in Indonesia. There are presently no laws or regulations specifically addressing the use and management of coastal or coral reef resources. Thus, conservation and management are regulated solely by a group of natural resource laws and regulations that are implemented in a sectoral manner.

The differences that arise in the standards of enforcement also occur among the natural resource management laws. Most of the sectoral laws establish sanctions and liability for similar offences but the sanctions for similar violations vary widely. For instance, the Fisheries Act penalties are up to six years in the prison and a fine up to USD 133,000. However for a similar violation, the Environmental Management Act No. 23 (1997) has similar prison penalties but a fine of up to USD 36,000.

Regardless of its quality, the success or failure of a law is measured by the degree of acceptance and compliance by society. Rapid and fair enforcement of MPA management policies is critical to achieve continued support and compliance of local communities. Despite the existence of laws that addresses coastal management, illegal fishing has continued to increase, a result of a consistent lack of enforcement and systematic corruption by public officers.

The enforcement of workable laws should provide security for the efforts and rights of a community managing its natural resources. If the community does not feel secure, it will result in a fundamental distrust of state laws and legal institutions.

Conclusions and Future Directions

Coral reefs have received much attention lately as the areas of highest marine biodiversity and are among the world's top conservation priorities. Hundreds of millions of people and thousands of communities all over the world depend on coral reefs for food, protection, and jobs. For example, over 150 million people live within the 'Coral Triangle' of Southeast Asia and Melanesia, of which over 2,600,000 are fishers who are dependent on marine resources for their livelihoods. Over the past 15 years, over one billion dollars have been spent on coral reef management projects worldwide ($320 million from the GEF alone).

One new concept that has been introduced in the past decade is 'resilience'. The central concept of 'resilience' may be defined as "the capacity of a complex system to absorb shocks while still maintaining function and to reorganize following disturbance". To date, concepts of resilience have generally been applied only to corals, in terms of their resilience to climate change, sedimentation, pollution, etc. In the context of coral reefs, "management for resilience" should prevent a coral reef system from failing to deliver benefits (i.e. biodiversity conservation, ecosystem function, food and income for poverty reduction) by preserving ecological and social features that enable it to absorb shocks (climate change, natural disasters, user conflicts, etc.) and maintain function.

Another key area for future research is identifying and mapping critical spawning and nursery habitats for a range of ecologically and commercially important species. Also important is a better understanding of the connectivity between spawning (source) and nursery (sink) habitats. This information is essential to designing effective MPA networks. Connectivity is also important in transboundary management, where MPAs or networks of MPAs span more than one jurisdiction.

Current MPA management practice does not place sufficient emphasis on threats that arise from outside the reef area. Climate change will have a profound effect on coral reefs and the coral reef resource (fishery) dependent peoples that live there. Any approach to biodiversity conservation and development must account for these impacts. In a development (i.e. poverty reduction) context, climate change must be viewed as a fundamental threat to human security in countries already vulnerable to social and economic dislocation and conflict.

Literature Cited

Amar, E.C., R.M.T. Cheong and M.V.T. Cheong. 1995. Small-scale fisheries of coral reefs and the need for community-based resource management in Malalison Islands, Philippines. Fisheries Research 25: 267-277

Ahmed, M., G.M. Umali, C.K. Chong, M.F. Rull and M.C. Garcia. 2007. Valuing recreational and conservation benefits of coral reefs — the case of Bolinao, Philippines. Ocean & Coastal Management 50: 103–118

Aswani, S. 1999. Common property models of sea tenure: A case study from the Roviana and Vonavona Lagoons, New Georgia, Solomon Islands. Human Ecology 27: 417–453

Aswani, S. 2002. Assessing the effects of changing demographic and consumption patterns on sea tenure regimes in the Roviana lagoon, Solomon Islands. Ambio 31: 272–284

Aswani, S., Albert, S., Sabetian, A. and T, Furusawa. 2007. Customary management as precautionary and adaptive principles for protecting coral reefs in Oceania. Coral Reefs 26: 1009-1021

Badalamenti F, Ramos AA, Voultsiadou E, Lizaso LJS and 6 others. 2000. Cultural and socio-economic impacts of Mediterranean marine protected areas. Environmental Conservation 27: 110–125.

Baelde, P. 2005. Interactions between the implementation of marine protected areas and right-based fisheries management in Australia. Fisheries Management and Ecology 12: 9-18

Balgos, M.C. 2005. Integrated coastal management and marine protected areas in the Philippines: Concurrent developments. Ocean & Coastal Management 48: 972–995

Berkes, F.E. 1989. Common Property Resources: Ecology and Community-Based Sustainable Development. Bellhaven Press, London.

Berkes, F., Colding, J., and Folke, C. 2000. Rediscovery of traditional ecological knowledge as adaptive management. Ecological Application 10: 1251–1262

Bode, M., L. Bode and P.R. Armsworth. 2006. Larval dispersal reveals regional sources and sinks in the Great Barrier Reef. Marine Ecology Progress Series. Volume 308: 17-25

Christie, P. 2004. MPAs as biological successes and social failures in Southeast Asia. In Aquatic Protected Areas as Fisheries Management Tools: Design, Use, and Evaluation of These Fully Protected Areas, J.B. Shipley, ed. American Fisheries Society, Bethesda, MD, pp. 155–164.

Cinner, J. 2005. Socioeconomic factors influencing customary marine tenure in the Indo-Pacific. Ecology and. Society 10: 36.

Cinner, J. 2007. Designing marine reserves to reflect local socioeconomic conditions: lessons from long-enduring customary management systems. Coral Reefs

Cinner, J.E., Marnane, M.J., and McClanahan, T.R. 2005. Conservation and community benefits from traditional coral reef management at Ahus Island, Papua New Guinea. Conserv. Biol. 19, 1714–1723

Cinner, J.E., Marnane, M.J., McClanahan, T.R., Clark, T.H., and J. Ben. (2005). Trade, tenure, and tradition: Influence of socio-cultural factors on resource use in Melanesia. Conservation Biology 19: 1469–1477

Cinner, J.E., and McClanahan, T.R. (2006). Socioeconomic factors that lead to overfishing in small-scale coral reef fisheries of Papua New Guinea. Environ. Conservation 33: 73–80.

Colding, J. and C. Folke. 2001. Social Taboos: “Invisible” Systems of Local Resource Management and Biological Conservation. Ecological Application 11: 584-600

Dirhamsyah, D. 2006. Indonesian legislative framework for coastal resources management: A critical review and recommendation. Ocean and Coastal Management 49: 68-92

Donaldson T.J. and Y. Sadovy. 2001. Threatened fishes of the world: *Cheilinus undulatus* Ruppell, 1835 (Labridae). Environmental Biology of Fishes 62: 428

Edgar G.J. and N.S. Barrett. 1999. Effects of the declaration of marine reserves on Tasmanian reef fishes, invertebrates and plants. Journal of Experimental Marine Biology and Ecology 242: 107–144

Fauzi, A. and E.A. Buchary. 2002. A socioeconomic perspective of environmental degradation at Kepulauan Seribu Marine National Park, Indonesia. Coastal Management, 30: 167-181

Ferrari, M.F. 2006. Rediscovering community-conserved areas in South-east Asia: peoples’ initiatives to biodiversity loss. Parks 16: 43-48

Francis, J., A. Nilsson and D. Waruinge. 2002. Marine protected areas in the eastern African Region: how successful are they? Ambio 31: 503–11

Friedlander, A.M., E.K. Brown, P.L. Jokiel, W.R. Smith and K.S. Rogers. 2003. Effects of habitat, wave exposure, and marine protected area status on coral reef fish assemblages in the Hawaiian archipelago. Coral Reefs 22: 291-305

Gibson, J., M. McField and S. Wells. 1998. Coral reef management in Belize: an approach through Integrated Coastal Zone Management. Ocean and Coastal Management 39: 229-244

Gladstone, W., N. Tawfik, D. Nasr, I. Andersen, C. Cheung, H. Drammeh, F. Krupp and S. Lintner. 1999. Sustainable use of renewable resources and conservation in the Red Sea and Gulf of Aden: issues, needs and strategies actions. Ocean and Coastal Management 42: 671-697

Johannes, R.E. 2000. Palau first in Indo-Pacific to protect reef fish spawning aggregations. In Salm, R., J.Clark, E. Siirila (Eds.) Marine and Coastal Protected Areas: A Guide for Planners and Managers. IUCN, 370 pp.

Johannes, R.E. 2002. The renaissance of community-based management in Oceania. Annual Review of Ecology and Systematics 33:317-340

Johannes, R.E., L. Squire, T. Granam, Y. Sadovy, and H. Renguul. 1999. Spawning aggregations of Groupers (Serranidae) in Palau. Marine Conservation Research Series Publ.#1, The Nature Conservancy. 144pp.

Jordan, A., M. Lawler, V. Halley and N. Barrett. 2005. Sea bed habitat mapping in the Kent Group of Islands and its role in marine protected area planning. Aquatic Conservation: Marine and Freshwater Ecosystems 15: 51-70

Katon, B.M., R.S. Pomeroy, L. Garces and A.M. Salamanca. 1999. Fisheries Management of San Salvador Island Philippines: A Shared Responsibility. Society and Natural Resources, 12: 777-795

Keller, B.D. and B.D. Causey. 2005. Linkages between the Florida Keys National Marine Sanctuary and the South Florida Ecosystem Restoration Initiative. Ocean & Coastal Management 48: 869–900

Knight, D., E. LeDrew and H. Holden. 1997. Mapping submerged corals in Fiji from remote sensing and in site measurements: applications for integrated coastal management. Ocean and Coastal Management, 34: 153-170

Light, P and G.P. Jones. 1997. Habitat preference in newly settled coral trout (*Plectropomus leopardus*: Serranidae). Coral Reefs 16:117–126

Lunn, K.E. and P. Dearden. 2006. Fishers' needs in Marine Protected Area zoning: a case study in Thailand. Coastal Management, 34:183–198

Majanen, T. 2007. Resource use conflicts in Mabini and Tingloy, the Philippines. Marine Policy 31: 480–487

McClanahan, T.R. 1994. Kenyan coral reef lagoon fish: Effects of fishing, substrate complexity, and sea urchins. Coral Reefs 13: 231–241.

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

McClanahan, T., and Shafir, S. 1990. Causes and consequences of sea urchin abundance and diversity in Kenyan coral reef lagoons. Oecologia 83: 362–370.

McClanahan, T.R. and R. Arthur. 2001. The effect of marine reserves and habitat on populations of east African coral reef fishes. Ecological Applications 11:559–569

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

McClanahan, T.R. and N.A.J. Graham. 2005. Recovery trajectories of coral reef fish assemblages within Kenyan marine protected areas. Marine Ecology Progress Series, 294: 241–248

McClanahan, T.R., S. Mwaguni and N.A. Muthiga. 2005a. Management of the Kenyan coast. Ocean and Coastal Management 18 : 901-931

McClanahan, T.R., Davies, J., and Maina, J. 2005b. Factors influencing resource users and managers' perceptions towards marine protected area management in Kenya. Environmental Conservation 32: 42–49

McClanahan, T.R., M.J. Marnane, J.E. Cinner and W.E. Kiene. 2006. A comparison of marine protected areas and alternative approaches to coral-reef management. Current Biology 16, 1408-1412

Miclat, E.F.B., Ingles, J.A. and J.N.B. Dumaup. 2006. Planning across boundaries for the conservation of the Sulu-Sulawesi Marine Ecoregion. Ocean & Coastal Management 49: 597–609

Milne, N. and P. Christie. 2005. Financing integrated coastal management: experiences in Mabini and Tingloy, Batangas, Philippines. Ocean and Coastal Management 48: 427-449

Monaco, M.E., A.M. Friedlander, C. Caldow and J.D. Christensen. 2007. Characterising reef fish populations and habitats within and outside the US Virgin Islands Coral Reef National Monument: a lesson in marine protected area design. Fisheries Management and Ecology, 2007, 14, 33-40

Myers, R.F. 1999. Micronesian Reef Fishes, 3rd ed., Coral Graphics, Guam.

Osborn, D. and A. Datta. 2006. Institutional and policy cocktails for protecting coastal and marine environments from land-based sources of pollution. Ocean and Coastal Management 49: 576-596

Patlis, J.M. 2005. The role of law and legal institutions in determining the sustainability of integrated coastal management projects in Indonesia. Ocean and Coastal Management 48: 450-467

Polunin, N.V.C. and C.M. Roberts. 1993. Spillover of exploitable fishes from a marine park and its effect on the adjacent fishery. Ecological Applications 10:1792–1805

Pollnac, R.B., Crawford, B.R., and 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., Pollnac, R.B., Katon, B.M., and Predo, C. 1997. Evaluating factors contributing to the success of community-based coastal resource management: The Central Visayas Regional Project-1, Philippines. Ocean and Coastal Management 36: 97–120.

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

Rhodes, K.L. and Y. Sadovy. 2002. Temporal and spatial trends in spawning aggregations of camouflage grouper, *Epinephelus polyphekadion*, in Pohnpei, Micronesia. Environmental Biology of Fishes 63:27–39

Richmond, R,H., T. Rongo, Y. Golbuu, S. Victor, N. Idechong, G. Davis, W. Kostka, L. Neth, M. Hamnett and E. Wolanski. 2007. Watersheds and coral reefs: conservation science, policy, and implementation. BioScience 57: 598-607

Riedmiller, S. 2000. Private Sector Managment of Marine Protected Areas: The Chumbe Island Case, In: Cesar H.S.J. (ed.), Collected Essays on the Economics of Coral Reefs, CORDIO, SIDA

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

Rudd, M.A. and M.H. Tupper. 2002. The impact of Nassau grouper size and abundance on scuba diver site selection and MPA economics. Coastal Management 30: 133–151

Russ, G.R. and A.C. Alcala. 1999. Management histories of Sumilon and Apo Marine Reserves, Philippines and their influence on national marine resource policy. Coral Reefs 18: 307-319

Russ, G.R. and A.C. Alcala. 2003. Marine reserves: rates and patterns of recovery and decline of predatory fish, 1983–2000. Ecological Applications13: 1553–1565

Russ G.R., A.C. Alcala and A.P., Maypa. 2003. Spillover from marine reserves: the case of *Naso vlamingii* at Apo Island, the Philippines. Marine Ecology Progress Series 264: 15–20

Russ G.R., A.C. Alcala, A.P. Maypa, H.P. Calumpong and A.T. White. 2004. Marine reserve benefits local fisheries. Ecological Applications 14: 597–606

Russ, G.R., Stockwell, B. and A.C. Alcala. 2005. Inferring vs. measuring rates of recovery in no-take marine reserves. Marine Ecology Progress Series 292: 1-12

Sadovy Y., M. Kulbicki, P. Labrosse , Y. Letourneur, P. Lokani and T.J. Donaldson. 2003a. The humphead wrasse, *Cheilinus undulatus*: synopsis of a threatened and poorly known giant coral reef fish. Reviews in Fish Biology and Fisheries 13: 327–364

Sadovy Y., T.J. Donaldson , T.R. Graham, F. McGilvray and 5 others. 2003b. The live reef food fish trade: while stocks last. Asian Development Bank, Manila

Sievanena, L., B. Crawford, R. Pollnacc, C. Lowe. 2005. Weeding through assumptions of livelihood approaches in ICM: Seaweed farming in the Philippines and Indonesia. Ocean & Coastal Management 48: 297–313

Sladek Nowlis, J and A.M. Friedlander. 2005. Marine reserve function and design for fisheries management. In: Norse EA, Crowder LB (eds) Marine conservation biology: the science of maintaining the sea's biodiversity. Island Press, Washington, DC, p 280–301

Stoffle, R. and J. Minnis. 2007. Marine protected areas and the coral reefs of traditional settlements in the Exumas, Bahamas. Coral Reefs 26, 4: 1023-1032

Sutinen, J.G., and Kuperan, K. 1999. A socio-economic theory of regulatory compliance. International Journal of Society and Economics 26: 174–193

Thiele, M.T., R.B. Pollnac and P. Christie. 2005. Relationships between coastal tourism and ICM sustainability in the central Visayas region of the Philippines. Ocean and Coastal Management 48: 378-392

Tupper, M. 2007. Spillover of commercially valuable reef fishes from marine protected areas in Guam, Micronesia. Fishery Bulletin 105:527-537

Tupper, M. 2007. Identification of nursery habitats for commercially valuable humphead wrasse (*Cheilinus undulatus*) and large groupers (Pisces:Serranidae) in Palau. Marine Ecology Progress Series 232: 189-199

Tupper, M.H. and M.A. Rudd 2002. Species-specific impacts of a small marine reserve on reef fish production and fishing productivity in the Turks and Caicos Islands. Environmental Conservation 29: 484-492

Williams, I.D., Walsh, W.J., Miyasaka, A, and A.M. Friedlander. 2006. Effects of rotational closure on coral reef fishes in Waikiki-Diamond Head Fishery Management Area, Oahu, Hawaii. Marine Ecology Progress Series 310: 139-149

Wolanski E, Richmond R, McCook L, Sweatman H. 2003b. Mud, marine snow and coral. reefs. American Scientist 91: 44-51

WWF Philippines. 2006. Tubbataha reefs: a marine protected area that works. WWF Philippines, Quezon City, Philippines. 22 pp.

Zann, L.P. 1999. A new (old) approach to inshore resources management in Samoa. Ocean and Coastal Management 42: 569-590

Zweig, R. 2006. Mindanao Rural Development Project. Implementation Completion Report TF 23302. The World Bank, Rural Development and Natural Resources Sector Unit, East Asia and Pacific Region