

Annex 2

**MARICULTURE AS A SUSTAINABLE LIVELIHOOD
STRATEGY IN SUPPORT OF CONSERVATION AND
MANAGEMENT – A CASE STUDY OF KOMODO NATIONAL
PARK, INDONESIA**

IMPROVING COASTAL LIVELIHOODS THROUGH SUSTAINABLE
AQUACULTURE PRACTICES

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FOREWORD

This report was prepared for STREAM, a NACA initiative, and aims to present a case study illustrating the benefits of establishing alternative livelihood programs, particularly related to mariculture, for conservation purposes. In their approach, The Nature Conservancy, partnering with Komodo National Park authorities, has integrated alternative livelihoods into the conservation strategy from the early start of their Komodo program in 1995. Komodo National Park represents one of few Marine Protected Areas (MPAs) in Southeast Asia where conservation at-scale is being achieved, where serious action is taken successfully to abate destructive fishing practices and other serious threats to the reefs, and mariculture activities form an important component in providing alternative livelihoods for park inhabitants. Technical expertise on aquaculture is combined with substantial biological, ecological and conservation expertise towards low-impact mariculture activities. A large amount and variety of information on technical and economic feasibility, and on perceptions from stakeholders, is available.

The author acted as an editor in utilizing and summarizing the vast amount of information that is available from the PHKA/TNC Komodo program. Credits and authorship must thus be granted to the entire collaborative team of PHKA and TNC. Dr P J Mous of The Nature Conservancy provided valuable comments in his review of the report. Sources used in this report can all be downloaded from www.komodonationalpark.org

Finally, as pointed out by Frank Vorhies of IUCN during long talks about the business of biodiversity, we should consider to stop using the phrase Alternative Sustainable Livelihoods or Alternative Income Generating Schemes. Destructive methods and over-fishing practices are by definition not sustainable, even while they may appear to provide benefits to many people over a relatively long period of time; this is merely the result of expanding collection areas into previously un-fished grounds. Thus, the word “alternative” could be left out and discussing Sustainable Livelihoods and Sustainable Income Generating schemes may help conservationists and fishers reach common understanding of what it is that management and regulation aims to achieve: sustainable exploitation and livelihoods under protection of biodiversity and ecologically-functional sites.

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EXECUTIVE SUMMARY

Together with the Indonesian Park Authority (PHKA), The Nature Conservancy has been working in Komodo National Park since 1995 to establish a marine reserve that 1) ensures long-term protection of the natural community structure, habitat and species of the coastal and marine ecosystems within and around Komodo National Park, and 2) protects a portion of the exploited reef fish stock to enhance fisheries in the traditional use zones inside the Park and in the waters surrounding the Park. This would protect and safeguard the marine biodiversity in the Park as a source of recruits for surrounding fishing grounds. One of the facilitating approaches to minimize pressure on the reef and demersal resources of KNP is the alternative livelihood program. Since 1997, TNC and PHKA conducted studies and developed facilities in support of production of grouper fingerlings. The aim is to provide these fingerlings to local communities for grow-out to marketable size. This project was created for two important reasons: to provide sustainable fish culture as an alternative to non-sustainable fishing practices in and around KNP, and to transform part of the Indo-Pacific capture-based (unsustainable) grouper fishery into a culture-based (sustainable) grouper trade. The other mariculture project component comprises seaweed culture. Furthermore, TNC/PHKA implements alternative livelihood projects in eco-tourism and offshore fisheries. These other projects are not discussed here.

Key characteristics of the fish mariculture project in KNP are the context of Marine Protected Area management and the full-cycle operation, which includes a local hatchery for fingerling production. Technical difficulties that have occurred along the way include collecting a healthy brood stock and providing sufficient food of good quality to maintain health. Furthermore, other difficulties were experienced in guiding the perception that these activities were initiated in support of KNP management, rather than for enrichment of some selected business entrepreneurs. Continued education and enhanced awareness of these issues have increased local understanding of the mariculture project, which is now instrumental in building an increasing constituency for management of KNP.

This case study aims to illustrate that mariculture activities could contribute greatly to conservation purposes and more sustainable use of natural resources. Thus mariculture can play an important role responding to dwindling natural fish stocks, through generating alternative incomes rather than through generating alternative sources of protein. When embedded in a comprehensive and integrated Marine Protected Area strategy, such as is the case in Komodo National Park, mariculture can greatly enhance local understanding and support for the need to protect certain parts of the marine and coastal environment to prevent further and imminent collapse of fisheries and related coastal communities' livelihoods. This point should be carried forward and put in the right policy and institutional context as a highly beneficiary impact of mariculture.

More attention should be directed to share the lessons learned within this context to educate policy-makers. The perception needs to shift from viewing mariculture as an opportunity to produce more fish, towards viewing it as an opportunity to support livelihoods, integrated with comprehensive Marine Protected Area management. Thus, mariculture, when designed to allow for low ecological impact and maximum community involvement and benefits, can contribute to turning the tide of dwindling stocks and collapsing community livelihoods.

1. INTRODUCTION

Throughout the world, it has been shown that fisheries management approaches such as restricting fishing effort through licensing; setting quotas and influencing catching efficiency through alternative fishing gear are extremely difficult to enforce and thus result in little reduction of pressure on fish stocks. Failure of these traditional fisheries management strategies is often used to make a case for producing fish protein through mariculture. However, rather than abandoning the need to better managed capture fisheries and direct all resources to start producing fish from culture, mariculture should be integrated with the fisheries management tool of choice: Marine Protected Area (MPA) management.

Confirmed by recent publications, for example, by the American Fisheries Society (Coleman et al., 2001), the most successful strategy is true enforcement of no-take zones in a network of MPAs. The location of these must be carefully selected to allow for maximum fish reproduction capacity and optimum functional larval dispersal. Also, site selection considerations need to include criteria of resilience against natural phenomena and climate change. Redirecting resources and technical assistance to establish selection and true implementation of a network of Marine Protected Areas with no-take zones would be a first requirement to safeguard part of the world's fish and marine biodiversity and some part of the fish reproductive biomass. It has been proven that through these processes marine reserves aid fisheries (Roberts et al., 2001).

Critics continue to debate the ecological function of MPAs but forget that for Indonesia, none of the officially recognized MPAs is fully implemented as of yet, and failure in producing hard evidence of stabilized reef conditions and fish populations is merely the result of limited capacity, either technical or financial, to run an integrated management program for the existing MPAs. Furthermore, there are few that encompass absolute no-take zones of scale. In Indonesia, MPAs are still regarded as an opportunity to raise tourism revenue rather than a way to "put money in the bank" for safeguarding ecosystems from collapse. Zonation plans more often reflect compromises between economic stakes than sound ecologically-based site selection to serve source and sink functions. Also, many conservation groups shy away from direct support for law enforcement or working with communities that create the problems. Rather, less confrontational approaches are taken. Often, participation in alternative income generating (AIG) schemes does not even require firm commitments from the actual "wrong-doers" to quit destructive fishing or leave alone particular areas or species. Evidence of conservation successes is hard to produce unless a fully integrated approach is taken that combines serious no-take-zone management with alternative capture methods, AIG schemes, education, awareness and implementation of collaborative responsibility schemes.

For Komodo, such an integrated approach has been designed and implemented since 1996 by the Komodo Park Authority aided by The Nature Conservancy (TNC). TNC is a USA-based environmental organization, whose mission is to preserve plants and natural communities that represent life on Earth by protecting the land and waters they need to survive. Together with the Indonesian Park Authority (PHKA), TNC has been working in KNP to establish a marine reserve that 1) ensures long-term protection of the natural community structure, habitat and species of the coastal and marine ecosystems within and around Komodo National Park, and 2) protects a portion of the exploited reef fish stock to enhance fisheries in the traditional use zones inside the Park and in the waters surrounding the Park (Meyer and Mous, 2002). This would protect and safeguard the marine biodiversity in the Park as a source of recruits for

surrounding fishing grounds. To obtain this goal, both parties identified some key issues to work on and the full details of the work plan are contained in “25 Year Master Plan for Management Komodo National Park Book 1: Management Plan” (PKA and TNC, 2000). This management plan describes strategies to achieve the main targets of protection, conservation, resource use, education, and an improved management system in a context appropriate for local socio-economic and cultural conditions. In the management plan, TNC and PHKA point out key components for consideration: management of natural resources, borders and zonation, legal issues and law enforcement, tourism, constituency-building and participatory planning, community development and alternative livelihoods, capacity-strengthening and training, management of park administration and infrastructure, and park finance (See also Appendix A).

The Komodo National Park (KNP) provides a case example where mariculture activities are integrated with Marine Protected Area (MPA) management. With this conservation purpose, it differs from generic coastal community economic development activities and it also puts the activities in a different institutional and policy framework: that of the Indonesian Protected Areas, administratively captured under the Indonesian Ministry of Forestry and Conservation. Another key characteristic is the full production cycle approach, including establishment of a local hatchery that produces fingerlings from local brood stock. Primary reasons for this are to prevent placing further full-cycle pressure on wild stocks and local brood stock prevention of diseases and genetic pollution.

Within the Komodo MPA context, the mariculture activities are mostly intended to contribute to enhanced management success by facilitating a transition towards sustainable activities for some of the coastal communities who obtain part of their income from unsustainable fishing techniques. Additionally, the strategy aims to provide a cultured source of high-valued fish from Indonesia for the Hong Kong-based life reef fish trade, the Indonesian supply for which presently includes mainly wild captured fish.

The Komodo case analysis will particularly focus on issues related to the above-mentioned special characteristics, while also providing general project descriptions:

Institutional and Policy Context: Background on the institutional and policy framework is provided, including descriptions of the roles and responsibilities taken so far by the different groups engaged in the collaborative management for Komodo National Park.

Local Inhabitant Livelihood Context: Background to the economic and social importance of sustaining livelihoods for park inhabitants who depend on natural resources is provided, including descriptions of current resource use and impacts of park management strategies.

Technical, Operational, Marketing and Financial Context: Background to the specifics of the mariculture activities is provided, including descriptions of the hatchery set-up, lessons learned and the status of the project in achieving objectives.

Communication and Outreach Context: Background to the position of the mariculture project within the overall protected area management strategy is provided, including descriptions of community-involvement in management, yet also providing recommendations for targeting a wider audience to enhance understanding of meaningful mariculture development in achieving conservation and sustainable livelihood objectives.

2. INSTITUTIONAL AND POLICY CONTEXT

It must be understood that while the Park was established to protect the unique Komodo Dragon, its marine richness and geographic and oceanographic position now mean that marine and coastal conservation in KNP serves a larger than local purpose only. While there is evidence of high levels of endemism, the large water masses flowing through the narrow straits separating KNP from Flores and Sumbawa, indicate that larval dispersal may serve reefs and fish populations in a wider area than Komodo alone. Further, the frequent occurrence of large migratory marine life also indicates the area's regional importance (Kahn, 2002). Thus, aside from local management objectives, management of Komodo National Park will also have a positive impact on regional conservation objectives. As such, the alternative livelihood projects that have been initiated do not just serve the purpose of facilitating adjustment of local communities to management regulations; it is focused to enhance success of KNP management. A lot of effort has been invested in the selection of livelihoods and in establishing a solid basis, both ecologically and economically, to make them work. Once the technical shortfalls are solved and the economic foundation is solid, the intention is also to manage the fish mariculture project¹ in collaboration with various partners from the private sector and communities.

Collaborative management is chosen to achieve conservation in KNP; yet where capacity of partners is still limited, the park authority continues to carry the mandate. This approach must be seen in the recent, incomplete, Indonesian trend of transition of shared responsibilities for management of resources. Where capabilities of other groups are sufficient, they may take on partial roles and responsibilities (see Appendix B), yet it is clear that there will always remain particular roles that need to stay with park authorities. National parks within Indonesia are national assets serving functions to the entire Indonesian society and even for Southeast Asia. Responsibilities that likely must stay with the central government are, for example, the design of national policy and law enforcement. Policy against use of such destructive fishing practices as bombs and cyanide, now made official in a 1991 Directorate General Decree, is an example of this (See also Appendix C).

In Komodo National Park (KNP), both blast fishing and cyanide fishing were common before the management of the park was intensified (Pet, 1999). Based on information from rapid rural appraisals, ecological assessments and fisheries studies conducted in the area, it was clear that the threat of illegal destructive fishing methods was the first major problem that needed to be addressed to protect the marine habitats of KNP. It was therefore decided to form a cross-sectoral enforcement team in which park authority, police, army and local governments work together to carry out a routine patrolling program, monitoring all fisheries activities in the park.

The routine patrolling program started on 28 May 1996. Patrols took place almost on a weekly basis but the frequency dropped to an average of only 1.5 patrols per month in 1997. The incidence of dynamite and cyanide fishing dropped significantly during the first period of intensive patrolling in 1996 (Pet, 1999). The routine patrolling program has led to several arrests of fishermen using destructive fishing methods in and around the park. A reduction of

¹ It must be noted that aside from developing mariculture of fish, seaweed culture also falls under the mariculture program (See Appendix E).

more than 75% was recorded for dynamite incidents. Developments in 1997, however, showed that the routine patrolling program should be kept up to prevent a return of destructive fishing, especially cyanide fishing for aquarium fish and for lobster, live groupers and Napoleon Wrasse. Recent monitoring data on the status of the reef habitat in Komodo National Park indicate a significant increase of live coral cover from 1996 to now (Pet and Mous, 1998, with 2000 update). For every 16-m² live coral cover in 1996 there was 21 m² of live coral cover in 2000. There are few sites in the world that can boast such improvement, especially considering the devastating impacts of the 1998 coral bleaching event that caused serious deterioration of reefs throughout the world (Cesar et al., 2003).

Komodo Field Office and PHPA staff were trained to record data on resource utilization patterns during routine patrols to determine who is doing what, where and when in the Park². Continued over time, these data will also show any changes in the behavior of fishermen due to management measures and indicate which groups of fishermen or areas in the Park need extra attention. Management responses already included:

- Designing of zonation and regulations in such a way that objectives can be achieved with a minimum of conflict with local resource users
- Determining which fishing groups pose threats to the Park and should therefore be targeted by enforcement programs and alternative livelihood projects, and
- Determining which type of fishing activities are particularly threatening and should be prohibited in the Park.

² This is in a situation preceding any implementation of marine zonation or regulations other than a ban on dynamite and cyanide fishing.

3. LOCAL INHABITANT LIVELIHOOD CONTEXT

Generally, establishing MPAs with no-take zones and regulation of activities in use zones implies regulating the level and type of resource extraction. This will affect some people that now live in an MPA, and in the short term, may affect the amount and type of products that come from an MPA. However – and this is important to note and supported by emerging strong scientific evidence – rather than MPAs being blamed for reducing fish productivity, they are the tools of choice for protecting fisheries against total collapse. Currently, some misperception exists, claiming that MPAs impact negatively on Government of Indonesia (GOI) intentions to produce vast amounts of fish and other marine products for the national economy and its society's benefits. Fortunately, senior staff members of the newly-formed Ministry of Fisheries and Marine Affairs in Indonesia understand well that it is actually the other way around: that without safeguarding parts of Indonesia's fishery stocks, the entire coastal fishery is doomed to collapse, leaving coastal communities in poverty. Regardless of the above facts, there is an employment issue related to MPA management implementation and to facilitating behavior change for sustained livelihoods for communities depending on resources in an MPA. Alternative livelihood generation is often initiated, thus enhancing the success of management schemes that include no-take zones and gear regulation.

In KNP, there are presently almost 3,300 inhabitants spread out over four settlements (Komodo, Rinca, Kerora and Papagaran). All villages existed prior to 1980 before the area was declared a national park. In 1928, there were only 30 people living in Komodo Village, and some 250 people on Rinca in 1930. The population increased rapidly, and by 1999, there were 1,169 people on Komodo, meaning an exponential growth. Nearly 17,000 people live in fishing villages directly surrounding the Park. Regular monitoring of resource utilization patterns within the park, combined with village interviews, indicate that Park inhabitants mainly derive their income from a pelagic lift-net fishery targeting squid and small pelagic fish, which does not threaten the coral reef resources of the Park. This fact provided a good scope for protection of the coral reefs in the area in cooperation with local communities (Bakar, 1996). The *bagan* fishery of local communities did need protection against over-fishing so that this advantage would not be lost through collapse of stocks of small pelagics. Non-*bagan* yields represent only some 5% in terms of weight of the total yield (*bagan* + non-*bagan*) landed by park inhabitants (Komodo and Rinca). Fishermen commented that non-*bagan* activities are still important to them, since middlemen exploit the *bagan* fishery, which leaves little of the profits for local fishermen (Bakar, 1996). Freeing the fishermen from these middlemen may be an important strategy in keeping them from destroying the reefs.

Several surrounding communities were involved in fishing with cyanide and other destructive methods and were over-fishing the fish and invertebrate stocks in the Park. The most important conclusion from the monitoring of utilization patterns was perhaps that the resources in KNP were most seriously threatened by outside communities from Sape, South Flores and Sulawesi. The most important threat to the coral reef ecosystem was, in the early years, still the use of hookah compressors and it was therefore addressed immediately. Shellfish such as abalone and pearl oysters were caught with compressors and by reef gleaning, both destructive methods. The same holds true for sea cucumber, whereas lobster were almost entirely caught by compressor fishing. KNP could not allow the compressor fishing to continue and park authorities and TNC have managed to implement a local ban on hookah compressor use through establishment of local legislation. Park inhabitants and

surrounding communities were little affected by this compressor ban since this was a minor activity for these communities, except perhaps for inhabitants of Pulau Mesa located just outside the Park. Although compressor activity was anyway already reducing for Pulau Mesa, the compressor fishers from this community had to be helped to change their practice and this community was engaged firstly in the alternative livelihood programs.

Further, resource utilization monitoring showed that the main yield category from non-lift-net activities in KNP was fish (almost 95%), mostly caught by gillnets and by trolling and bottom hook and lines. Demersal trolling lines or *kedo kedo* were wiping out the coral trout stocks, bottom hook and lines took all predators and bottom long lines were decimating the sharks and large groupers. These gear types formed considerable threats to the demersal and sedentary fish stocks in the Park, and gillnetting had to be banned from the National Park as soon as possible. Heavy hook and line fishing by outside fishers from Sape focused around the grouper spawning aggregation sites, which aggravated the situation. Large amounts of spilled nylon fishing line were encountered at fish spawning aggregation sites and certain species like *Plectropomus areolatus* were decimated before actual spawning took place. In a concentrated effort, park authorities and TNC managed to establish fishing bans at sites where groupers and Napoleon Wrasse were known to aggregate for spawning. Population characteristics are being continuously monitored in a routine fish spawning aggregation site (SPAGS) monitoring program³. Also, total demersal fishing effort in the Park was greatly reduced through establishing no-fishing zones at all reefs. Communities affected by both measures were then also engaged in alternative livelihood programs.

While no specific household economics are available for local fishers who have been impacted mostly by the improved management of KNP – the blast and cyanide fishers – estimates of these incomes from other areas indicate that especially blast fishing is not of extreme high individual profitability (Pet-Soede et al., 1999). The large-scale live grouper wild-capture fishery provides a different picture with high individual profitability (Pet-Soede, unpublished). Thus, even when farming of grouper was going to be successful at the level of local communities, wild-capture still provided an attractive financial incentive for fishers, and strict enforcement against use of illegal substances such as cyanide remained necessary. When successfully implemented, enforcement could shift the financial balance (now including costs related to increased risk of arrests and penalty in court) more positively towards the farming of grouper rather than wild-capture (Appendix D).

³ Monitoring methods first designed with help of Lyle Squire, and improved by TNC in their routine monitoring program, are being used for training of partner groups at other sites including Bunaken National Park in north Sulawesi (reports at www.komodonationalpark.org), at Karimunjawa National Park in Java, and at Pohnpei (Pet et al., 2001)

4. TECHNICAL, OPERATIONAL, MARKETING AND FINANCIAL CONTEXT

The region-wide preference to develop live food fish businesses is fuelled by the high demand for live fish (mostly grouper and Napoleon Wrasse) from the Southeast Asian regional business centers of Hong Kong, Singapore, Japan and mainland China. Growth and reproductive biology characteristics of the most wanted species, combined with high levels of fishing pressure on these fish stocks (Mous et al., 2000), means that this high demand cannot be continuously fulfilled from operations that depend on fishing in the wild. Yet, mariculture development requires investments in appropriate technology and infrastructure, and live food fish industry members are not really lining up to provide such investments.

Perceptions of live food fish industry members (82 middlemen and 92 fishermen) on mariculture of the disappearing target fish were assessed in five provinces around Indonesia: Southeast Sulawesi, South Sulawesi, East Nusa Tenggara, West Nusa Tenggara and Lampung (Halim, 2002). Some 41% of the middlemen and 50% of fishermen had noticed that the abundance of wild grouper is decreasing and most of the people interviewed see mariculture as a solution. Some 95% of the middlemen claimed that they are ready to start grouper mariculture business, while 74% of the fishers would be ready to join if they had the assurance that this would be as profitable as capture in the wild. One important issue identified by Halim as key to adoption of mariculture activities relates to the time delay that exists because fish needs considerable time to grow to marketable size. Further, it was mentioned that skills and knowledge required for grow-out of grouper fingerlings need to be enhanced through well-directed training and capacity-building activities.

To support this and to overcome initial lack of interest by business members in investing in development of mariculture, and to allow for learning about best practices, TNC has taken the leading role of investing in the initial phases of establishing multi-species reef fish mariculture. Technical expertise is brought to the project through partnerships with Gondol Research Institute (Bali, Indonesia), the Department of Primary Industries (Queensland, Australia) and the Network of Aquaculture Centers in Asia-Pacific (NACA, Bangkok, Thailand) (Meyer and Mous, 2002).

Starting in 1997, a method to obtain fingerlings from the wild was tested in the Komodo area with the assistance of consultants from the Philippines (Mous et al., 1999). This method, *gango*, has already been used extensively in the Philippines. After one year of field trials, it was concluded that *gango* puts an additional fishing pressure on the wild stocks, both those of grouper and non-target fish. Therefore it was decided not to implement *gango*, but to produce fingerlings from captive brood stock (Meyer and Mous, 2002). This required establishment of a hatchery to produce fingerlings for grow-out by communities.

The next phase of the mariculture project included technical surveys, consultation with experts, development of partnerships, and development of a business plan for a hatchery and grow-out industry in the Komodo area. Identified by fish culture consultants in 1997, important strengths of the Komodo area included:

- It offers considerable potential for a wide range of marine farming enterprises.
- It is relatively unique in a number of mariculture attributes.

- It has a low annual rainfall (100 cm) that is confined to two months of the year.
- It is not in a typhoon area.
- It consists of a series of islands with virtually no land run-off and hence stable water quality.
- It has a large number of both deep water and shallow sheltered sites, suitable for mariculture.
- It has a number of sites suitable for establishment of a marine hatchery.
- It has an existing live fish trade.
- It has an extensive fishing community with associated knowledge and infrastructure.
- It has a good local source of breeding stock.
- It will implement exclusive use rights in multiple-use zones for local communities, and
- It has local expertise in holding and raising wild-caught fish in floating cages.

Based upon these recommendations, TNC established 2.4 tons of brood stock in fish cages near the proposed hatchery site. A one-year development project was implemented, aiming to establish the hatchery, develop a steady production of larvae, achieve good survival and growth rates of larvae, and train local staff in hatchery practices. Basic environmental impact assessments (EIA) have been carried out (UKL/UPL), as required under Indonesian law, and were approved by the District Planning Agency (BAPPEDALDA). The approval was followed by a letter of recommendation of the *Bupati* (District Head) of Manggarai District (Meyer and Mous, 2002). This phase was concluded successfully in late 2000, when fishes in the broodstock were shown to spawn spontaneously in the holding cage facility.

Throughout this period, preparations for construction of the land-based hatchery were conducted. Land was donated for this purpose by the Tahija Foundation and, based on the Strategy and Action Plan of 2001 (TNC, 2001), blueprints for construction were prepared. Construction started in April 2002 and the hatchery is now almost completed. Once the hatchery is producing fingerlings, local communities can become involved in grow-out. Four grow-out units have been planned, each consisting of a complex of 16 floating cages, varying in size between 9 and 25 m² surface area. These facilities would aim to produce 25 tons/year per grow-out unit over 3-4 harvests for their first try-out year. Grow-out is prepared for Estuary Grouper (*Epinephelus coioides*), Mouse Grouper (*Cromileptes altivelis*), Tiger Grouper (*Epinephelus fuscoguttatus*), Seabass (*Lates calcarifer*) and Mangrove Jack (*Lutjanus argentimaculatus*) (Meyer and Mous, 2002). This multi-species approach reduces risks related to species-specific vulnerability to disease and to fluctuation in consumer preference and price. The species composition of the first batch of fingerlings depends on hatchery practicalities, as this batch will be used for training in grow-out in village-based fish farms rather than for the generation of revenue. The grow-out process takes 11-22 months depending on species, until the fish reaches 0.5 kg of weight.

In anticipation of the grow-out phase, where local villagers will be employed at the mariculture project to learn necessary skills, villagers have visited the broodstock facilities and posters have been distributed that explain the concept behind the project. Eventually, the enterprise plans to collect larger quantities of grown-out fish to sell to fish trading companies

(already visiting the area with live fish transport vessels). As soon as production of fingerlings and grow-out are feasible and economically viable, final steps will include identification of business partners to take over the enterprise. Local communities will be supported to take over the grow-out enterprises and establish business relationships with the mariculture enterprise. Systems of controls, checks and balances will be put in place to ensure responsible and sustainable development. A franchising system is presently under consideration. A carrying capacity analysis will be conducted to determine the optimal production capacity, and the project will be handed over to another group under the condition that “best practices” will be adhered to. This group may be a fishery cooperative or a local business partner.

Under conditions of best practices, the project may still not provide similarly large financial incentives to the live reef fish trade. As indicated by Halim (2002), the profitability for fishers and middlemen is thought to influence the extent to which mariculture of groupers can replace the wild-caught grouper trade. Investments to maintain the hatchery are too high to be carried by local fishermen, yet as explained earlier, local supply of good quality fingerlings produced in a hatchery is of key importance:

- It allows application of best practices for fish production.
- It prevents capture of wild-stock juveniles through providing a steady stream of high-quality fingerlings in firmly set supplier-community relations.
- It prevents introduction of diseases and genetic pollution through introduction of “foreign” DNA .
- It provides a good opportunity for control of the entire production cycle with even potential positive benefits of certification of the production process.

An expert team provided a first assessment of the economic viability. The recommended business plan envisages that Seabass and Estuary Grouper would be used to get experience with hatchery techniques during the start-up phase of the project, after which the focus will be changed to Mouse Grouper, which is more profitable, but its culture also poses more technical challenges. The business plan concluded that to start up a hatchery-based grow-out enterprise in two years, with a capacity of 27 tons/year, capital requirements amount to US\$ 280,000. Operational costs in the first three years would amount to US\$ 460,000, and the enterprise would break even after five years. After the facility is fully operational, annual profits would amount to US\$ 435,000.

To measure the profit for fishermen is not easy. Their need for instant cash cannot be filled with future higher incomes (Halim, 2002). While issues related to the delay in receiving first revenue for grow-out must be dealt with in some way, the total profitability of this alternative will depend on whether or not there is a market for cultured groupers. Blind taste tests conducted by TNC years ago in Hong Kong indicate that little difference was experienced between wild-caught and cultured grouper, yet the market for live grouper is largely based upon the fact that target species are somewhat elusive and rare. Farmed grouper will then be less appealing to consumers who wish to experience a rare treat.

5. COMMUNICATION AND OUTREACH CONTEXT

As indicated above, one of the facilitating approaches to minimize pressure on the reef and demersal resources of KNP is the alternative livelihood program (Widodo, 2002). Aside from the mariculture project, two other major projects have been initiated so far in coordination with local communities. One is to enhance opportunities for fishers to engage in sustainable pelagic fisheries (Halim and Mous, 2000). Before the alternative livelihood program started, most pelagic fisheries focused on squid and a large variety of highly abundant pelagics – such as Spanish mackerel, yellow-fin tuna, skipjack, anchovies, sardines, sprats, Indian mackerels, and scads – provided a high-price potential that was hardly exploited. One important step to enhance the productivity was to place several Fish Aggregating Devices (FADs) around KNP. This pulls fishers away from the reefs, reducing the pressure there, and results in fairly-efficient pelagic fish catches as these aggregate near the FADs. Further, TNC and PHKA, together with fishermen groups and local fish traders, are also working on post-harvesting practices, fish processing techniques and marketing of large pelagic fish. Training aims to produce a variety of high-quality products such as dried-salted, salt-boiled, *katsuobushi* and spiced-dried. A new demand for frozen fish such as tunas is also coming up and the building of an ice plant or freezing facility is being considered.

Another component of the livelihood program focuses on eco-tourism activities. Studies in 2002 resulted in an inventory of other alternative livelihood opportunities proposed by local communities. The list of options identified by the communities includes carving, weaving, making cake and pastry, sewing and embroidery, with names of people that are interested in each activity. These activities would support eco-tourism activities in KNP, as visitors will seek specific handicrafts from KNP. Together with local NGOs, TNC and PHKA are empowering local communities, especially women, to enhance skills required to conduct these new activities. The training also aims to enhance general understanding on conservation issues, so that the output of the alternative livelihood program will be thorough.

All alternative livelihood projects create opportunities to engage in education and awareness-building with local communities and private sector industry on best practices and ecological and economic sustainability in relation to a well-managed KNP. As at most other MPA locations in Indonesia, a major misunderstanding hampers successful implementation of protected areas and this is with the role of MPAs for fisheries management. Scientific evidence of the supportive role of MPAs for protection of fisheries livelihoods from total collapse are not easily translated or explained to local communities and the private sector, who most often think in a short time-span forced by relative poverty or disinterest in a sustained level of natural resources. Even when scientific evidence is presented graphically (for example in Appendix F), local stakeholders are wary of the short-term impacts of zonation plans and management plans. To enhance understanding of the role of conservation in protecting livelihoods, park authorities and TNC engage in education and outreach activities. For this purpose, a series of films, booklets and school kits have been designed. Further, stakeholder meetings are frequently held to explain to concerned villagers and to invite constructive input to share responsibility over sustained resources in and around KNP. The alternative livelihood engagement of local communities and the private sector further enhances a local constituency for park management.

Additionally, while the experience in the KNP mariculture project shows that full-cycle farming of some high-valued reef fish is possible, there is urgent need for guidance on best practices in mariculture throughout Indonesia. For many species, technology and knowledge is still lacking for full-cycle farming and any license or other support to set up other high-value grouper fish farms in Indonesia must be regarded with utmost care as the business may actually engage in grow-out of wild-caught animals, rather than in full-cycle farming, and thus continue to exert pressure on the reef fish populations (Sadovy and Pet, 1998). Understanding of the ecology and biology of fishing and fish farming or fish rearing is limited at the Indonesian management level. While this must be urgently enhanced through well-directed training and awareness campaigns at national policy and regional administrative levels, a limited policy should be considered in the case of issuing of mariculture licenses.

Finally, and following trends in consumer preferences towards sustainable produced fish, mariculture development would benefit from certification schemes that provide additional marketing value to fish produced under best practice conditions. Awareness and outreach campaign activities could thus enhance support for mariculture and transformation of unsustainable wild-capture of target species.

6. CLOSING REMARKS

It is proven around the world that the production of fish through mariculture is technically viable. Under conditions of ample funding and expertise – such as in this case study – mariculture activities could contribute greatly to conservation purposes and more sustainable use of natural resources. Thus mariculture can play an important role in responding to dwindling natural fish stocks by enhancing MPA management results.

When embedded in a comprehensive and integrated Marine Protected Area strategy such as in Komodo National Park, mariculture can greatly enhance local understanding and support for the need to protect certain parts of the marine and coastal environment to prevent further and imminent collapse of fisheries and related coastal communities' livelihoods. This point should be carried forward and put in the right policy and institutional context as a highly beneficial impact of mariculture.

More attention should be directed to share lessons learned within this context to educate policy-makers. There should be a shift from the perception of a need for producing more fish, towards the understanding that mariculture, when well-designed to allow for low ecological impact and create maximum community involvement and benefits, can contribute to turning the tide of dwindling stocks and collapsing community livelihoods.

Additionally, and preferably in the form of certification and eco-labeling schemes, marketing strategies should be initiated to increase awareness of the need for management and transformation of fisheries and to increase the demand for sustainable cultured fish. This would provide local communities with a real incentive to change behavior.

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APPENDIX A SUMMARY OF 25-YEAR MANAGEMENT PLAN COMPONENTS FROM BOOK 1

(downloadable from www.komodonationalpark.org)

Management: The master plan identifies two components for resource management: 1) Co-management with the Provincial Government and Local Communities, and 2) Adaptive Management. For co-management, a new structure that includes a Collaborative Management Board, Collaborative Tourism Council, and Community Stakeholder Board is recommended. This type of management emphasizes a bigger role for the district governments in Manggarai and Bima, as these districts are the gate entries to the Park. For Adaptive Management, a process that is based on new information from the field is described, including recommendations on data collection methodology and a schedule.

Borders and Zonation: The KNP was declared as a national park in 1980 with total area of 1,817 km². In the 25-year management plan, an additional 504 km² is proposed based on a rapid ecological assessment, which noted that there are still places that contain high diversity of fish and coral outside the existing borders and also that there is need for a buffer zone. As for zonation, a new design was proposed based on ecological data, current understanding of ecological and conservation principles, socio-economic and cultural needs of the local communities, and feasibility. It contains zones called Core, Wilderness, Tourism Use, Traditional Use, Pelagic Use, Special Research and Training, and Traditional Settlement. The detailed descriptions and permitted and prohibited activities are listed.

Legal Issues and Law Enforcement: TNC and PHKA collated legal regulations dating from 1915 to the present that relate to KNP establishment. Overlapping jurisdictions, such as the right to give fishing permission and loopholes, were identified and both parties allowed five years to evaluate the issues. Meanwhile, for implementing the day-to-day legal obligations and law enforcement, the capacity of park rangers is strengthened and facilitation of patrol is provided.

Tourism: TNC and PHKA have designed an eco-tourism concept with all stakeholders, especially the private sector, local dive operators and tourist guides. Eco-tourism activities vary from watching the famous Komodo Dragon and savanna, to marine activities like diving or fishing with special permits. The strategies for eco-tourism also define how to minimize negative impact on natural resources and local communities, while generating income for park financing.

Constituency-building and Participatory Planning: Aware of the complexity of ecological processes and competing natural resource uses, a management strategy that emphasizes constituency-building and participatory planning was designed. A coordination forum that includes local stakeholders is actively discussing and reviewing the sustainable establishment of KNP, including park enforcement, zonation and alternative livelihood opportunities. An environmental education and awareness program that will involve local communities, government, local NGOs, universities and mass media is included.

Community Development and Alternative Livelihoods: There are three target sectors identified with local communities: pelagic fisheries, mariculture and eco-tourism. In the

pelagic fisheries project, techniques are upgraded with Fish Attracting Devices (FADs), infrastructure is enhanced to maintain product quality, and training is given to enlarge variety of products. In the mariculture project, two types are developed: for food fish such as groupers, and for culture of seaweed. For the food fish project, a hatchery is developed and for seaweed culture, training was conducted and set-up facilitated. For the eco-tourism project, training of guides and operators is provided to raise awareness on conservation values of best tourism practices.

Capacity-strengthening and Training: A variety of targeted training courses are provided to enhance skills of KNP personnel. A work plan to improve management through education and training has been designed.

Management of Park Administration and Infrastructure: Recommendations for managing park administration and infrastructure are provided, including organizational structure, responsibilities for each staff position, personnel requirement, needs for restructuring of management and coordination, and development of facilities and infrastructure.

Park Finance: A tourism concession is recommended, aside from government subsidies.

APPENDIX B SUMMARY OF PROPOSED COLLABORATIVE MANAGEMENT STRUCTURE FOR KNP

(from fact-sheet “Collaborative Management Initiative in Komodo National Park”, downloadable from www.komodonationalpark.org)

The goal is a well-managed self-sustaining park, i.e., effectively protecting the biodiversity in the park, enhancing fisheries around the park, maximizing benefits to local communities, and ensuring use of the park’s resources for tourism and education in a sustainable way.

The Komodo National Park 25-year management plan was developed in association with extensive coral and fish monitoring programs, comprehensive community outreach and conservation awareness campaigns and sustainable livelihood activities, and a strong cross-sectoral patrolling and enforcement program. The implementation of the plan and the ongoing conservation efforts will only be sustainable when these two critical constraints are addressed: 1) limited park management capacity, and 2) decline in the government budget to support Marine Protected Areas in Indonesia. It is difficult under present circumstances for one single agency to manage a large number of protected areas. Collaborative management strengthens effective management of protected areas and has become the accepted practice worldwide. A collaborative management initiative and a long-term financing plan have been developed to address the key constraints for professional and effective management of the Park.

Collaborative Management: Institutional-strengthening and Capacity-building

Komodo National Park is embarking on a collaborative management approach, involving all key stakeholder groups in the management of the protected area. These include the park authority (PHKA), local government, a joint venture between an international NGO (TNC) and a local tourism company (Jaytasha Putrindo Utama), as well as local communities, government agencies, and private sector organizations. A tri-partite collaborative management agreement between the joint venture, called *Putri Naga Komodo*, PHKA and the local government is being developed to strengthen the park’s capacity in conservation management, monitoring and enforcement and sustainable livelihood activities, awareness programs and eco-tourism activities.

In the Proposed Collaborative Management Structure for KNP there is ample room for local communities and the private sector to engage in advising and decision-making processes.

Tourism Concession: Long-term Financing

The 25-year management plan establishes an Eco-tourism Concession with the goal of protecting the park’s bio-diversity and generating revenue required for the park in a way that is environmentally sound, socially responsible and economically viable. While the collaborative management agreement provides the governance structure for the management of the park, the Tourism Concession will be responsible for financial management, investments in park infrastructure and marketing. A joint venture (JV) company *Putri Naga*

Komodo has been established to run the concession. The charter of the JV directs that any profits and revenues earned will be invested back into conservation. The rationale behind the agreement was based on a proven track record of each partner in investing in KNP, as well as complementarity between the conservation NGO and the tourism-oriented private sector company. This concept has been presented at various national and local meetings for government audiences, NGOs, the tourism sector and local communities. In addition, it has been presented at several international and national conferences and workshops to solicit feedback and comments.

A controlling shareholding in the concession ensures TNC's ability to fulfill its obligation to ensure the compatibility of all activities in the park. To ensure compliance with the collaborative management and concession agreements, bio-diversity conservation benchmarks will be evaluated regularly by the Government of Indonesia, public financial auditors and international organizations (such as IUCN and UNESCO).

Indonesian law requires that the concession include an Indonesian shareholder. To enhance the standard and the quality of visitation facilities, and the experience visitors have in the park, a joint venture company was formed between TNC and an Indonesian company with extensive tourism expertise and experience, which has been selected as a minority shareholder in the concession. It is expected that an enhanced visitor experience will justify increased user fees by foreign visitors to support protection of the park. At appropriate fee levels, the park is expected to achieve financial self-sustainability in 7-15 years. Incentive mechanisms are being developed to ensure the sustainable use and protection of the park's resources. Regulatory compliance systems will also be put in place and/or strengthened. As the concession terms are still under negotiation with the Ministry of Forestry, they are not yet publicly available. We can state unequivocally, however, that the terms and conditions explicitly state that, "the objective of the concession is to sustain the preservation of bio-diversity in the park by generating revenues based on eco-tourism activities and building on-site capacity". Shareholders will not, under any circumstances, make any financial gain from the company established for this purpose as stated in the JV articles of association. All revenue generated in and from the use of the park will be used specifically and only for management and conservation of the park, and to continue to fund existing local communities and government interests.

The Indonesian National Park Authorities under the Ministry of Forestry will have the full mandate over park management and enforcement activity. A micro-enterprise fund for local family-based businesses and a community development grant system will be developed to finance urgent welfare needs. No exclusive or preferential rights to any aspect of park entry or use will exist in any form, to anyone. Equal access to the park by all users is assured, subject only to total visitation numbers from all sources not exceeding a rigorous science-based assessment of the sustainable carrying capacity of the park. There will be no hotel or resort development in the national park and concession area.

This is a fundamental transformation in park management towards a more professional management system. The involvement of the public and tourism sectors and local communities will be assured through their on-going representation in the advisory council to the collaborative park management, consisting of three divisions: public sector, local communities living in and around the park, and the private tourism sector. This represents a groundbreaking policy experiment for the government of Indonesia and for management of protected areas in general.

APPENDIX C SUMMARY OF INDONESIAN LAWS ON THE SEA AND ITS RESOURCE EXPLOITATION

Legislation Relating to Commercial Marine and Coastal Fisheries

Legislation	Year	Description
Ministerial Decree (Agriculture) No. 607	1976	Areas for Catching Fish
Presidential Decree No. 39	1980	Abolishment of Trawl Nets
Ministerial Decree (Agriculture) No. 607	1978	First stage in Implementing the Abolishment of Trawl Nets
Ministerial Decree (Agriculture) No. 633	1980	Implementing Directive on the Abolishment of Trawl Nets
Act No. 4	1982	Basic Provisions for the Management of the Living Environment
Act No. 5	1983	Indonesian Exclusive Economic Zone
Act No. 9	1985	Fisheries
Ministerial Decree (Agriculture) No. 473a	1985	Determination of Total Allowable Fish Catch
Act No. 17	1985	Ratification of Principles of the Archipelagic Concept and United Nations Convention on the Law of the Sea (UNCLOS)
Presidential Decree No. 26	1986	Ratification of ASEAN Agreement on the Conservation of Nature and Natural Resources
Ministerial Decree (Agriculture) No. 417	1988	Utilization of the Fishery Resources in the Indonesian Exclusive Economic Zone
Act No. 5	1990	Conservation of Living Natural Resources and Their Ecosystems
Government Regulation No. 15	1990	Business in Fisheries
Presidential Decree No. 32	1990	Management of Protected Areas
Directorate General Decree No. 1k/220/d4.744/91k	1991	Catching Fish with Prohibited Substances/Instruments
Presidential Decree No. 23	1991	List of Business Fields Closed to Investment (Includes Utilization and Exploitation of Sponges)
Act No. 5	1994	Ban on Catching the Napoleon Wrasse Fish (<i>Cheilinus undulatus</i>)

Source: Llewellyn (2000, unpublished)

Legislation Relating to Marine Migratory Species

Legislation	Year	Description
Ministerial Decree (Agriculture) No. 35	1975	Protection for Several Types of Wild Animal (Dolphins)
Presidential Decree No. 43	1978	Ratification of Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES)
Ministerial Decree (Agriculture) No. 327	1978	Protection of Several Types of Wild Animals (Whales, Dolphins, Crocodiles, Leatherback Turtle)
Ministerial Decree (Agriculture) No. 716	1980	Protection of Several Types of Wild Animals (Whales, and Grey, Olive and Loggerhead Turtle)
Presidential Decree No. 26	1986	Ratification of ASEAN Agreement on the Conservation of Nature and Natural Resources
Ministerial Decree (Forestry) No. 12	1987	Protection of Several Types of Wild Animals (Black Coral, Giant Clams and Other Marine Invertebrates)
Act No. 5	1990	Conservation of Living Natural Resources and Their Ecosystems
Government Regulation No. 7 and 8	1999	Protection for Several Types of Wild Animals (Coelacanth and Green Turtle)

Source: Llewellyn (2000, unpublished)

APPENDIX D SUMMARY OF HOUSEHOLD BENEFITS OF DESTRUCTIVE FISHING PRACTICES

Midpoint Estimates of Monthly Average Income in US\$ for Crew and Owners of Destructive Fishing Operations in Indonesia

Destructive Activity	Small-scale	Medium-scale	Large-scale
<i>Blast fishing ('97)</i>			
- Crew	55	146	179
- Owner	55	393	1,100
<i>Cyanide fishing</i>			
<i>* Food fish ('97)</i>			
- Crew	100	252	400
- Owner	100	413	35,000
<i>* Aquarium fish ('02)</i>			
- Crew	120	253	114

APPENDIX E SUMMARY OF ECONOMICS IN THE LIVE REEF FOOD FISH TRADE

Fishing with poisons can be considered a traditional fishing method in the sense that it has occurred for hundreds of years, all over the world (Eldredge, 1988). Chemical poisons like sodium cyanide (NaCN) and potassium cyanide (KCN) appeared recently in fisheries and were mainly used in the aquarium trade. Here, concentrations are not meant to kill but only tranquilize the fish, which facilitates their capture. This feature was gratefully used when a market for high-quality live food fish emerged from Hong Kong, Taiwan and mainland China (Johannes and Riepen, 1995). This live food fish trade concentrates on groupers (especially the genus *Epinephelus* and *Plectropomus* and the species *Cromileptes altivelis*) and Napoleon Wrasse (*Cheilinus undulatus*).

The high prices paid for these fish make it feasible for owners and middlemen to employ skilled divers and use relatively advanced methods to capture the fish and keep it alive. A diver with a squirt bottle filled with cyanide solution uses hookah dive gear to roam reefs for target species. Once spotted, he chases the fish into a crevice and squirts the solution to stun the fish. If successful, he breaks away the coral and grabs the fish to put it in a net or on a hook after which he brings it slowly to the surface. An epidermic needle, or sometimes a simple straw, is used to “vent” the expanding swim bladder.

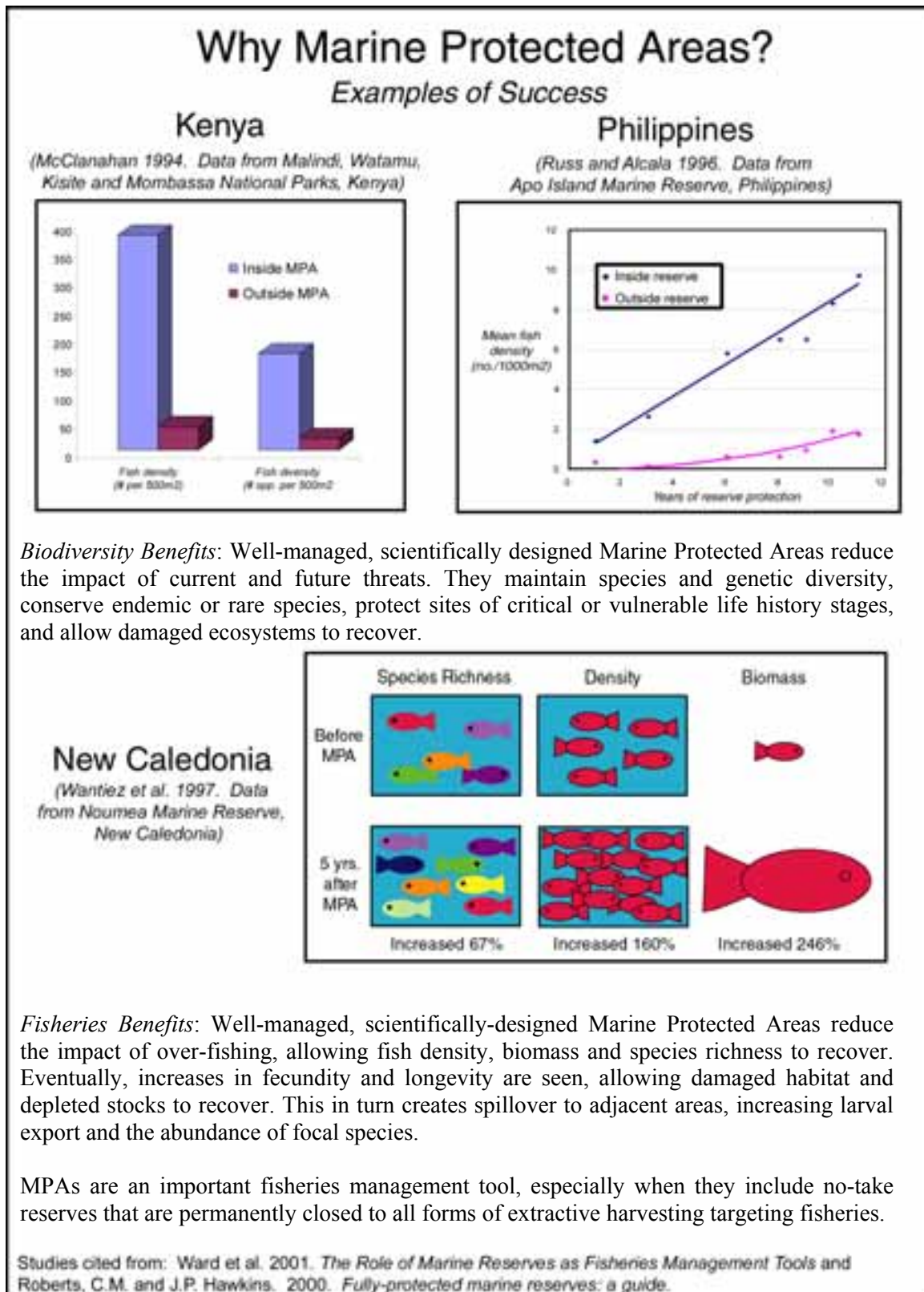
Groupers and Napoleon Wrasse migrate many miles each season to come to spawning sites to reproduce (Samoilys and Squire, 1994). Experienced cyanide divers are skilled in locating them; thus wiping out fish at an aggregation site equals the elimination of top predators from several square miles of reef. Sizes of cyanide operations vary from single outboard engine canoe operations to large-scale mother ships with several dinghies and some 20 crew. Catches vary accordingly and so do costs. Unpublished data show average net profits per boat-owner and per month in the cyanide fishery in 1997 of US\$ 100 for small-scale operations with the owner as a single crew member, US\$ 413 for medium-scale operations with the owner not forming part of the crew but owning several boats, and no less than US\$ 35,000 for large-scale operations. Crew members on average earned incomes per month of US\$ 100 in small-scale operations, US\$ 252 in medium-scale operations and US\$ 400 in large-scale operations including average bonuses for good catches. These profits and incomes are higher than profits and incomes in any type of conventional fishery.

APPENDIX F SUMMARY OF THE SEAWEED MARICULTURE PROJECT

A total of 34 participants from 12 villages took part in the seaweed farming training in 2000 (Pedju et al., 2002). Additional support was also provided for each participant, such as rope, bamboo, anchor, plastic, seed, buoys and dried materials. Each participant started cultivating 100 square meters of plantation area, in front of the villages surrounding KNP. Growing of seaweed started in April 2001 in the targeted villages of Pulau Seraya Besar, Pasir Panjang, Pulau Kukusan, Manjaga, Pulau Papagaran, Pulau Mesa and Bajo Pulau.

At present, there are 100 families, divided in ten groups, involved in the project. Each family successfully developed their planting areas to 300-400 square meters. The main buyers in Sape purchased dry seaweed products at an average price of Rp 3,500/kg (US\$ 0.30-0.40/kg). The harvest time (45 days) is relatively short. Within this period one family can produce (on average) dry seaweed products of about 75 kg per 100 sq m, which is worth (on average) Rp 250,000. Capital costs for each harvest of 75 kg amount to some Rp 75,000. Each family currently cultivates 300-400 sq m and produces about 250 kg of dry seaweed per planting cycle with a value of Rp 875,000, at a cost of about Rp 275,000. This is currently resulting in a net income of about Rp 600,000 (US\$ 60) per cycle per family. Each family is expected to complete about eight cycles per year and will produce around two tons per year. Total production of dry cultured seaweed by the 100 families in the development project is expected to be around 200 tons per year.

APPENDIX G EXAMPLE OF POPULAR TRANSLATION OF MPA AS A FISHERIES TOOL CONCEPT



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