Reconciling Fishing and Environmental Protection:
Resources Enhancement Strategies for the Conservation and Management of Fisheries

by Theo Ebbers

Introduction

Rapidly declining fish stocks and populations, particularly in tropical small-scale coastal fisheries, are usually attributed to two factors: over-fishing and the deterioration of ecosystems, which are critical for sustaining coastal fish populations.

As noted during the ASEAN-SEAFDEC Millennium Conference, the widespread degradation of coastal and marine habitats has greatly affected the productivity of fisheries, and reduced their contribution to local food security. Measures to stop or even reverse these trends are urgently required, and methodologies to restore and enhance coastal aquatic habitats need to be explored and developed. In the Resolution on Sustainable Fisheries for Food Security in the ASEAN Region, adopted at the Millennium Conference, ministers responsible for fisheries in the ASEAN Region recommended to "work towards the conservation and rehabilitation of aquatic habitats essential to enhancing fisheries resources." The Plan of Action for ASEAN, formulated during the Conference, reflects this ministerial recommendation by including the optimization of the use of "inshore waters through resource enhancement programmes."

> "the widespread degradation of coastal and marine habitats has greatly affected the productivity of fisheries, and reduced their contribution to local food security"

Following the ministerial recommendations of the Millennium Conference and based on the Plan of Action, SEAFDEC subsequently designed several corresponding programmes to address over-fishing and the deterioration of ecosystems through the promotion of innovative fisheries management approaches. With the aim of promoting the establishment of sustainable fisheries, programmes include decentralization and the introduction of rights-based fisheries (see *Fish for the People* Vol.1 No. 2) as well as a programme to enhance coastal fisheries resources. This resource enhancement programme seeks to develop strategies to carefully modify coastal habitats in order to restore or increase their productivity. The feasibility, the potential ecological impacts and the socio-economic consequences of such

efforts are the focus areas of SEAFDEC's present resource enhancement programme.

Strategies to enhance coastal fisheries resources were discussed recently at a regional workshop conducted by the SEAFDEC Training Department. Discussion focused on the various methodologies and techniques for resource enhancement suggested at the Millennium Conference, notably artificial reefs, stationary fishing gear, restocking programmes and marine protected areas.

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This article is a reflection of the discussions and results of this workshop, and looks at the various facets of resource enhancement strategies suggested and discussed.

Increasing fisheries production and conservation – maintaining the balance

Abundant fish resources and sustainable fisheries depend on a healthy and productive marine environment, with habitats providing optimal conditions for fish to reproduce. The widespread degradation of coastal ecosystems has severely affected the ability of marine organisms to maintain plentiful stocks. Resource enhancement strategies aim to restore the productivity of these damaged habitats to their former levels, and even to further increase the ecosystem's natural production capacity. This will be achieved through careful responsible interventions and manipulations, which try to ensure that habitat conditions are the most favourable for fish reproduction.

Modifications to increase the productivity of aquatic eco-systems have a long history. For many centuries, fishers the world over have altered coastal ecosystems to increase fish catch and production. The most prominent of habitat manipulations are the deployment of artificial reefs (ARs), or fish attracting devices (FADs). Other structures have been used to grow and culture valuable marine products like mussels and oysters, or simply to trap fish. Traditionally, the main purpose of structures such as ARs or stationary fishing gear has been to

increase catch and production of fish and other aquatic organisms, but it is now recognized that they may also contribute to the general enhancement of the coastal marine environment by providing suitable substrate and habitats for bottom dwelling and other marine organisms.

These artificial reefs and other man-made structures in water bodies are often used to illustrate their value as tools for the rehabilitation and enhancement of degraded coral reefs and other important marine habitats. The workshop therefore focused much of its discussion on the environmental and fisheries impact of structures like ARs and Stationary Fishing Gear (SFG) on coastal waters.

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Another strategy for fishery resource enhancement discussed during the workshop was restocking. This strategy has a relatively long history, going back more than a hundred years. Traditionally, it strives to rebuild declined or collapsed fish stocks through the mass release of cultured fish into the wild.

While ARs and restocking programmes are usually directly aimed at increasing fish catch, the establishment of Marine Protected Areas (MPAs), also discussed during the workshop, aims primarily to protect, conserve and regenerate critical habitats and declining fish stocks. Supporters of MPAs claim that they provide benefits to fisheries through spill-over effects from rebuilt fish stocks to fishing grounds surrounding the area under protection. On the other hand, conventional fisheries managers often reject MPAs as a tool for fisheries management, because they fear the socio-economic consequences of excluding large areas from fishing grounds.

Resource enhancement programmes in the region

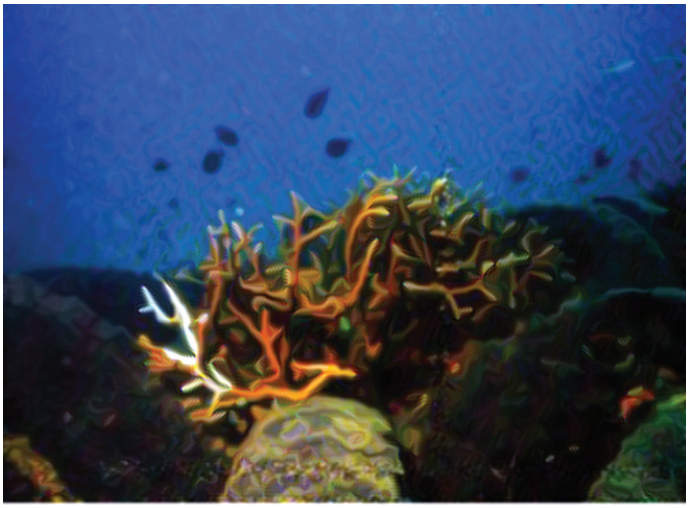
Box 1 shows that all of the ASEAN-SEAFDEC Member Countries promote at least one, and often more than one, of these resource enhancement tools.

A brief look at the objectives of these programmes shows that each of these tools can be used for various purposes, and that each may have various conflicting impacts on the coastal marine environment and fisheries resources. Generally, activities promoted by SEAFDEC Member Countries focus on the following objectives:

- To mitigate habitat losses caused by natural disasters and human activities
- To improve marine productivity and the biodiversity of coastal resources
- To increase fish catch in coastal waters
- To provide physical obstructions against the invasion of trawlers into coastal areas
- To provide productive and alternative near-shore

Box 1. Overview of resource enhancement programmes in ASEAN-SEAFDEC Member Countries

- **Cambodia** and **Myanmar** are currently promoting only MPAs, but intend to expand to other potential measures, such as ARs.
- **Singapore** is promoting restocking to increase resident fish abundance, but also has an artificial reef programme. SFGs in Singapore are currently not promoted, as these structures are potential obstacles in Singapore's narrow shipping lanes.
- **Vietnam** is in the initial stage of implementing ARs.
- **Brunei** has a programme to install ARs and MPAs.
- **Thailand** focuses mainly on the deployment of ARs, and is currently conducting a pilot project to promote SFGs. Thailand also has a number of marine parks and protected areas, which are under the jurisdiction of the Royal Forestry Department. The Department of Fisheries has established a three km-wide zone from the shoreline, protected from trawling activities.
- **Indonesia** and the **Philippines** both have extensive programmes for ARs and MPAs. The promotion of SFGs is among one of the priority areas of the Bureau of Fisheries and Aquatic Resources in the Philippines.
- **Malaysia** has established a number of large marine parks, and pursues an extensive artificial reef



fishing areas to small-scale fishermen, and

· To promote sustainable livelihoods such as eco-tourism and small-scale selective fishing in the use of coastal marine resources.

The ambiguity of these major resource enhancement strategies with regards to fisheries, as reflected by the diversity of the objectives listed above, can be summarized in one question: What are the net-gains and benefits for fisheries resources? Much academic and fisheries management debate revolves around this question, with currently available scientific data not providing any clear answer. This lack of reliable and verifiable data on ecological impacts and economic benefits has led to much vigorous – and frequently very emotional – argument on resource enhancement strategies and tools.

An overview of ARs, FADs and SFGs

As mentioned above, the deployment of artificial reefs to increase fish catch has a long history. Fishers have long been aware that any kind of structure in the water attracts fish. Trees and tree trunks, rocks, bamboo, and old fishing boats have all often been used to create such structures and enhance fishing. With the introduction of modern technologies and materials, fishers started to experiment with structures made of used car tyres, concrete, PVC pipes and other materials which promised to be durable enough to withstand currents and wave actions for a long period of time.

"What are the net-gains and benefits for fisheries resources from these resource enhancement strategies?"

A reef is defined as "a ridge of coral or rock in a body of water, with the top just below or just above the surface," (Encarta ® World English Dictionary ©1999) so structures similarly placed by fishers are usually called 'artificial reefs.' Floating structures made from bamboo and other materials, which also have a long tradition in creating gathering points for fish, commonly known in the region as 'payao,' are usually not considered to be artificial reefs, but are referred to as "Fish Attracting Devices" (FADs). Following this characterization, one can see that all ARs are FADs, while not all FADs are ARs, so explaining the difficulty of distinguishing the two categories. Some countries, like Malaysia, therefore differentiate between ARs and FADs, by referring to their purpose: FADs are installed in order to attract fish and to increase the catch; ARs are installed to rehabilitate a degraded or disturbed coral reef area, and to increase fish abundance.

Unlike floating devices, ARs not only attract fish but also provide substrate and habitats for many benthic, sessile and demersal marine organisms. Among the ASEAN-SEAFDEC Member Countries, Japan is the most experienced and advanced at utilizing ARs to maximize fisheries production through designing specific ARs as habitats, spawning grounds and shelters for specific species. Other countries in the region have tried to learn from the Japanese experience, and have developed similar artificial reef programmes, but often the investment necessary for assembling such ARs is beyond the budgetary priorities of the economically weaker countries. Nevertheless, with growing concern about environmental degradation and habitat loss, ARs made from cheap and affordable materials have become a common tool for trying to rehabilitate essential coastal habitats such as coral reefs in many countries of the region.

"ARs made from cheap and affordable materials have become a common tool for trying to rehabilitate essential coastal habitats of the region"

The success or failure of an artificial reef programme can be measured only in relation to its main purposes.

Case studies of AR projects from all over the Southeast Asian region show that several objectives can often be attributed to the installation of ARs. Usually aimed at increasing fish catches for local fishermen, ARs are often deployed to protect shallow coastal waters from the damaging effects of trawl net operations. The widespread degradation of coral reefs has also led to the deployment of ARs to create an environment that is conducive to the recovery of coral reefs areas.

Stationary Fishing Gear (SFG) is included in this discussion on ways to enhance coastal fisheries resources, because their complex assemblage not only serves as a tool to catch fish but, like ARs, they also provide substrate and shelter for many bottom dwelling aquatic plants and animals. The growth of benthic organisms on structures like ARs and SFGs is often very impressive, and their supporters take this as a proof of their capacity to improve coastal ecosystem productivity and enhance coastal fisheries resources.

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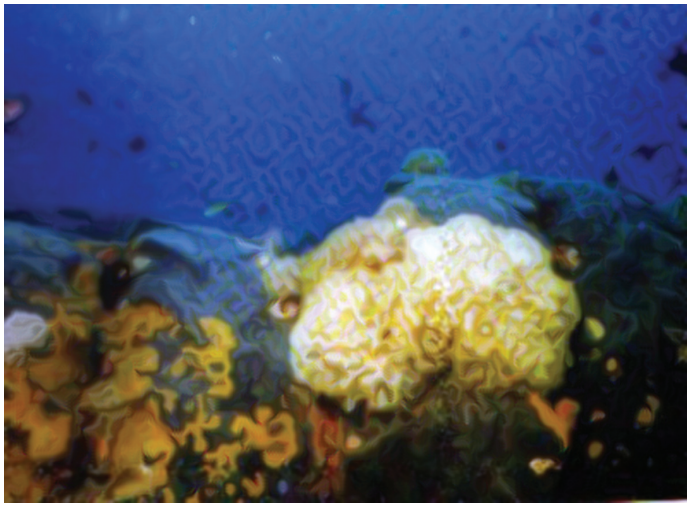
Yet critics often point out that it is not clear to what extent all these structures, especially ARs, actually induce recruitment of more fish to the fishery. They argue that ARs and other structures may actually cause an acceleration of resource depletion, since fish attracted to and gathering around these structures can be caught much easier, draining areas around the ARs of their fish. To avoid this, it is been suggested that ARs, FADs and SFGs should be installed under a strict management system. Both the fishing effort around these structures and the number of such structures in a given area need to be regulated. In some Member Countries, there are initiatives to allow the installation of ARs only within a no-fishing zone of Marine Protected Areas or in Marine Parks. Under an open-access regime, the potential benefits of all these tools may be quickly dissipated by unregulated fishing activities.

The art of deploying artificial reefs

It is therefore important to carefully choose the right location for the installation of AR structures. Common



sense alone tells us that ARs have to be set in areas where the substrate can support the structures – if the sea bottom is too muddy or sandy, the AR may slowly sink into the ground. To be of any use as a fishing ground for local fishers, ARs must be installed in near-shore areas, accessible to small, traditional crafts. If set in too deep water or too far from the shore, fishers will not be able to take full advantage of the potential benefits of the ARs. Meanwhile, ARs installed in very shallow waters may obstruct navigation, will be subjected to wave action, and will be prone to be ruined by storms. In areas of high sedimentation and siltation, ARs may soon be covered by silt. In such conditions, corals and other sensitive sessile organisms may not be able to settle, because of poor light conditions or because of the abrasive effects of the sediments in the water.

ARs should be carefully designed, not only to meet modern engineering standards of durability and stability, but – of much greater importance – to imitate as closely as possible the natural environment and habitats. While researchers and marine scientists point out that each specific purpose of an AR requires a corresponding specific design, in reality ARs are often established with little or no ecological consideration, and often without any prior consultation with marine biologists. Case studies from the Southeast Asian region show that local political considerations are often more important in designing and implementing AR programmes than ecological considerations. Usually, the driving force behind such programmes is the promise of a short-term increase in fish catch, while the potential long-term effects and sustainability play only minor roles in the rationale and justification for these programmes.

The pros and cons of Marine Protected Areas

There is increasing, undisputable evidence that MPAs can in fact have enormous positive environmental impacts. Unlike conventional fisheries management tools, which were mostly developed for single species fisheries of temperate zones, the Marine Protected Areas (MPAs) protect whole ecosystems and consequently seem to be better suited to protecting and managing tropical multi-species fisheries. The benefits for fisheries, as claimed by the advocates of MPAs, arise from spill-over effects into adjacent areas. Considering the potential positive effects of MPAs, some fisheries managers and conservationists question the usefulness of ARs in the rehabilitation and enhancement of essential coastal and marine ecosystems. They ask what additional benefits ARs can provide if MPAs can increase fish abundance, density, biodiversity, and total biomass by – in some cases – several hundred percent.

> "There is increasing, undisputable evidence that MPAs can in fact have enormous positive environmental impacts"

Still, conventional fisheries managers and fishermen doubt this claim, as they fear that fishing pressure outside and especially along the boundaries of the MPA will increase and rapidly dissipate any spill-over effects. This phenomenon has already been observed outside several MPAs. Positive MPA effects outside the protected area may result in increased competition and fishing effort, which will encourage fishers to apply new fishing techniques that in turn produce higher catches, but at the same time destroy the ecosystems in the fishing grounds around the MPA.

Like AR programmes, the establishment of MPAs is often based on political considerations and priorities at the local level. Conservation issues and the potential benefits for sectors other than fisheries, such as tourism, are key motivating factors behind the establishment of MPAs, which often limit fishing in a particular area, but not other human activities. Like AR programmes, any effort towards establishing a MPA should have clearly specified goals and objectives, against which their success and effectiveness can be measured.

The MPA sites need to be as carefully selected as the sites of ARs. Their potential environmental and social impacts must both be analysed before the size and design of the MPA are determined. A large MPA may have excellent results in resource recovery and rehabilitation, but quite negative impacts on the fisheries sector, as the remaining fishing ground may become too small to provide any benefits to fishers. On the other hand, if its designers try to keep as much fishing ground for fishers as possible, a MPA may be too small to have any positive ecosystem effects.

> "Conventional fisheries managers and fishermen

Box 2. The terminology of Marine Protected Areas

The discourse on the fisheries benefits of MPAs is somewhat confused, as it centres on various terms, each used with various meanings. The Regional Guidelines for the Code of Conduct for Responsible Fisheries tries to clarify the various terms, proposing the following definitions:

Marine Protected Areas

A marine area (including offshore and coastal habitats) set-aside by law or any other effective means to conserve and protect part or the entire enclosed environment, and for which management guidelines have been established.

Marine Park

A marine reserve that allows multiple uses through zoning, and in which conservation-oriented recreation, education and research are emphasized.

Closed Area

Closure of an entire fishing ground for a particular fishing gear, or a part of it, for the protection of a section of a population (such as spawners and juveniles), the whole population or several populations. The closure is usually seasonal, but it could also be permanent (FAO).

Two other terms commonly used in the region, *Marine Reserves* and *Sanctuaries*, are not defined in the regional guidelines, but are usually understood to mean 'no-take zones' – in other words, areas where absolutely no fishing is allowed.

Taking the lead from the Regional Guidelines, this article uses the term MPA in a generic sense, meaning any area where fishing effort and practices are strictly regulated to protect the area from overfishing and environmental degradation. In practice, most such areas include a 'core area,' in which no fishing is allowed and a buffer-zone, in which only very selective, traditional fishing, such as hook and line, are permitted.

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To be most effective, MPAs need also to be accompanied by corresponding coastal resources and fisheries management programmes. The establishment of MPAs to recover critical coastal ecosystems (for example, in waters affected by pollution from agricultural run-offs or urban wastes) will be ineffective in improving fish stocks if efforts are not linked with corresponding measures aimed at reducing negative impacts. If the aim of a MPA is to increase fish production, it won't be effective if established in areas where ecological conditions can't support large fish populations. Similarly, if the main objective of a MPA is the protection of critical habitats from fishing activities, it makes little sense to establish one in an area that traditionally has not been used as a fishing ground.

Ultimately, MPAs will only be an effective tool if accompanied by fisheries management efforts which aim to regulate fishing in areas surrounding MPAs in order to avoid potential negative impacts caused by excessive and destructive fishing pressure outside the area.

Restocking also requires fisheries management

Such ecosystem considerations are equally important for restocking programmes. To enhance or replenish depleted fish stocks through the release of hatchery-produced seeds, a restocking programme has to ensure that the released fish can reproduce before they are harvested. The production of seeds of commercially important fish species in hatcheries and their subsequent mass-release will only enhance stocks if the fish becomes self-sustaining thereafter. This can only be achieved through the introduction of harvesting regulations, or in other words, through the integration of restocking activities into a comprehensive fisheries management programme, which regulates fishing activities in areas where seeds have been released. In this context, the most promising approach would probably be to conduct restocking programmes within a decentralized management framework, which provides harvesting rights for the released fish to clearly defined users .

The promotion of one species over other species within a given area or ecosystem needs to be considered carefully. Local fishers and potential beneficiaries should be involved in selecting the target species of a restocking programme. Species selection should be based both on socio-economic and on biological criteria. While the selected species should be commercially important and attractive, biological characteristics such as their amenability to being bred and reared in hatcheries, and the potential impact of their mass-release on other species and on the eco-system, need to be carefully considered as well. The availability of food and niches for the selected species in the environment were it to be released should also be considered, while trying to maintain maximum biological diversity to safeguard the ecosystem's stability.

"The most important consideration for restocking programmes is probably the genetic integrity of populations and biodiversity"

Site selection is another critical issue in restocking programmes. Release sites need to be as carefully selected as sites for establishing Marine Protected Areas or installing Artificial Reefs.

The most important consideration for restocking programmes is probably the genetic integrity of populations and biodiversity. Often seed are released into areas in which the natural population has different genetic characteristics to those of the released seeds. Hatchery seed is frequently selected by hatchery operators for its capacity to grow and breed in an artificial environment. To avoid any negative impacts on population genetics,

A diver explores one AR, recently installed, made of concrete with a singular football shape

restocking programmes should ensure that the breeders used to produce the seeds are either taken from the intended release site or at least have the same genetic characteristics as the local stock.

"coastal resources enhancement project can have detrimental impacts [...] unless it is integrated into a comprehensive coastal fisheries resources management package"

The promotion of restocking programmes in the region should be based on a further clarification of these issues in order to avoid potential negative impacts and to assure their economic and ecological viability and sustainability.

On the need to promote a wider coastal management programme

The discussion on technologies and strategies for SEAFDEC's coastal resources enhancement project demonstrates clear ambiguity. Each can have detrimental impacts rather than the desired fisheries resources enhancement impact unless it is integrated into a comprehensive coastal fisheries resources management package. The fish-attracting properties of an AR require the strict management of fishing activities in their areas; the potential conse-quences of a fishing ground reduction through the establishment of protected areas requires the regulation of fishing activities in these areas; restocking programmes need to be accompanied by management interventions to ensure their success.

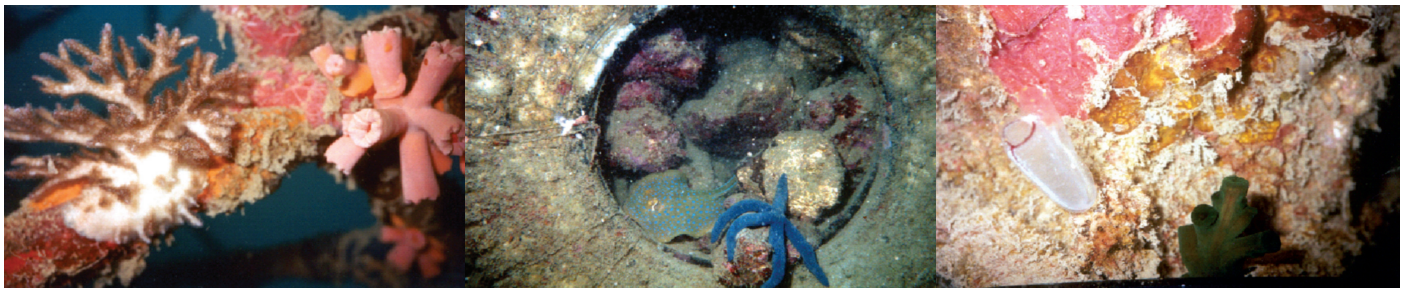
"No single resource enhancement technology can be successful unless integrated into a wider coastal management programme"

Discussion of resource enhancement methodologies raises questions of user and ownership rights: to whom do the ARs or the released fish belong? Who has a right to fish in the vicinity of an AR or MPA? These questions need to be addressed by corresponding integrated management packages, within a framework of decentralized co-management system, in which user and access-rights are clearly defined. Under the de facto open-access coastal fisheries regimes currently prevalent in the region, any potential benefits from these and other resource enhancement methodologies might quickly disappear under unrestricted and unregulated exploitation pressure from the resource users.

No single resource enhancement technology can be successful unless integrated into a wider coastal management programme. As a component of an integrated coastal management and development programme, coastal resources enhancement methodologies have great potential to increase fish production without further depleting fish stocks and other aquatic resources. In implementing such comprehensive approaches, one needs to recognize the relationship between conservation and sustainable fisheries management. These are not mutually exclusive, as traditional representatives of both the conservationist camp and fisheries managers often maintain, but represent the two sides of the same coin. To quote from the FAO definition for sustainable, ecosystem-based fisheries management: "The overarching principles of ecosystem-based management of fisheries ... aim to ensure that … the capacity of the aquatic ecosystems to produce food, revenues, employment and … other essential services and livelihood, is maintained indefinitely for the benefit of the present and future generations … to cater both for human as well as ecosystem well-being. *This implies conservation of ecosystem structures, processes and interactions […and…] consideration of a range of frequently conflicting objectives* and the needed consensus may not be achievable without equitable distribution of benefits.' (FAO Fisheries Atlas, 2nd edition, Rome, 2003).

Conclusion

In their efforts to make the fisheries sector both more



Box 3. Artificial Reefs: the Carmen experience (by Karsten Schröder, DED)

Carmen is a small town of 20,000 people, located on the northeastern coast of Cebu Island in the Philippines. Besides basic agricultural production like corn, coconut, and bamboo, one of the major income-generating activities is fishing. In the local frame, this translates into marginal fishing.

In the Philippines, indiscriminate overexploitation of once bountiful marine resources and the use of destructive fishing methods and inappropriate land-use technologies, including logging, have resulted in a drastic reduction in fish catch, with ever-increasing impoverishment and malnutrition as a consequence.

The near-shore marine areas are characterized by a rocky/sandy beach. Soft bottom patches with intermittent rock formations provide only a limited substrate for establishment of hard corals.

In 1998, two small peoples' organizations in the coastal barangays (villages) of Luyang and Malbago decided to install several artificial reefs in a previously established 16.7 hectare municipal MPA. With the support of a local NGO and technical assistance from the German Development Service (DED), the fisherfolk drew up a plan and identified a suitable location for the AR installation, based on criteria of water depth, light penetration, currents and wave action. Two types of modules were chosen for establishment:

1. A quadrangular shaped arrangement of eight used truck tyres per module; on land, tyres were connected with rubber straps from slashed tyre material and were transferred on a raft to the site, and then sunk by divers. Limestone rocks of a size that could be handled by a person were transferred to the site and dumped into the rubber modules to provide substrate for coralline growth and niches for smaller fish. At the same time this heavy limestone material would prevent the modules drifting away.

2. The other modules were made of galvanized iron pipes; these were soldered into pyramid shapes about 2 metres high. Limestone rocks were placed on top of the structures and in the intersections respectively, thus providing a surface area for microorganisms and invertebrates to settle, and adding weight to anchor the structure.

A total of 110 rubber modules and 270 pyramid-type modules were installed at depths varying from 15 to 22 metres. Being part of, and installed within, a MPA, fishing activities are regulated through a consensus of local fishermen. No fishing is allowed in the core zone of the MPA, and only hook and line, and occasionally gill-net fishing, are allowed within the buffer zone around the MPA. Daily patrols by the fishermen ensure that the no-fishing zone and other fishing regulations around the MPA are respected. Visual inspections of the AR have been conducted several times, and a complete survey was carried out in 2002, while another is planned for the end of 2003. After one year, the first colonies of encrusting corals were observed on the rubber tyres. Pictures taken after years show various genera of hard corals on the metal pyramid type of ARs.

Although no regular fish catch monitoring is conducted, there is circumstantial and anecdotal evidence that fish catch has improved, leading to a 20 % to 40 % increase in the income of local fishers. As the ARs are within the no-take zone of the MPA, this increase has to be attributed to spill-over effects from this area. Whether this increase in productivity within the MPA could have been achieved without the ARs cannot be determined, but the fisherfolk of Carmen believe that the establishment of the artificial reefs within the MPA has contributed greatly to the increase in fish catch. Another, and probably more important, impact of the AR installation is the feeling of ownership that the fisherfolk have developed through their active participation in finding ways to become resource managers.

responsible and more sustainable, fisheries managers and policy makers have to acknowledge that any fisheries management intervention, be it conventional or innovative, will have short-term socio-economic impacts, which need to be mitigated. A cost-benefit analysis should be conducted for all new resource enhancement technologies and fisheries management practices. Such an analysis needs to answer the question of whether the potential economic benefits derived from these measures justify the investment in their implementation, and will help to identify the most effective and efficient management approaches for sustainable fisheries.

To ensure that such efforts in the ASEAN Region contribute to the long-term sustainability of fisheries, regional guidelines for responsible resource enhancement methodologies should be developed. This requires intensive studies and environmental impact assessments of each of the resource enhancement methodologies introduced, through regional pilot projects. Different management approaches and packages should be included in these pilot studies in order to test them under different ecological and socio-economic conditions.

"regional guidelines for responsible resource enhancement methodologies should be developed"

The results of such research programmes will greatly contribute to the establishment of coastal resource use practices, and will help realize the full potential of coastal ecosystem productivity in a sustainable manner, for greater food security in the ASEAN Region and for the benefit of the people of Southeast Asia.

About the author

Dr. Theo Ebbers is currently working with SEAFDEC Training Department (TD) as training advisor on coastal management and extension methodologies, and with SEAFDEC Secretariat as expert on innovative approaches for the management of small-scale fisheries. His field of expertise is with Integrated Coastal Area Management and Development, and Participatory Planning Approaches.