FISH for the PEOPLE

A Special Publication for the Promotion of Sustainable Fisheries for Food Security in the ASEAN Region

Volume 7 Number 3: 2009 Bangkok, Thailand, ISSN: 1685-6546

Enhancing the Fishery Resources for Sustainable Development and Food Security

Southeast Asian Fisheries Development Center

Editor in Chief (Fish for the People)

SEAFDEC Secretariat
Kasetsart University Campus
P.O. Box 1046 Kasetsart Post Office,
Bangkok 10903, THAILAND
fish@seafdec.org

Editorial

Enhancing the Fishery Resources for Sustainable Development and Food Security

The world's ever increasing population would need additional amounts of food fish for their nutritional requirements. Such recognized need could not be satisfied if the fishery resources keep on declining. Considering therefore such scenario, it is necessary to maintain a resources-based equilibrium with fish demand on one side and fish supply on the other. This would mean balancing conservation and exploitation of the resources, to satisfy the demand and at the same time sustain the supply.

As an unlimited gift of nature, fishery resources should be considered as food bank for the future generations. The fishery resources contain big capital which is the whole aquatic ecosystem and earning interests in terms of the harvestable stages of the life cycle of the aquatic species. In order to maintain and sustain the capital, only the interests should be withdrawn and harvested, leaving the capital to flourish and allowing it to continuously produce interests. While it has always been a common perception that fishery resources are renewable, this picture has already changed and now the fishery resources have been viewed as no longer infinite. Thus, there is a need to properly manage such resources as food bank in order to ensure their sustainable contribution to food security for the future generations. However, since fisheries continue to become a market-driven sector, the resources may no longer be able to sustain the rapid and uncontrolled exploitation unless proper management is in place.

In order to continuously promote sustainable fisheries management, the other aspect of food security that focuses on the need to enhance the incomes of fishers should also be addressed to maintain the resources-based equilibrium. This could be achieved through the promotion of sustainable use of the fishery resources that the fishers have always depended on for their subsistence. SEAFDEC has been advancing the concept of "limited access regimes" through the promotion of rights-based fisheries that could facilitate the management of fishing capacity and the adoption of responsible fishing gear and practices. Also known as resource-based activities, the practice of responsible fisheries coupled with interventions such as enhancement

Production of this publication is supported by the Japanese Trust Fund.

FISH for the PEOPLE
A Special Publication for the Promotion of Sustainable Fisheries for Food Security in the ASEAN Region
Volume 7 Number 3: 2009 Bangkok, Thailand, ISSN: 1685-6546

CONTENTS

of the habitats would lead to improved production and food security.

Moreover, various approaches have been fostered and adopted in the Southeast Asian region to promote sustainable fisheries management for food security. We have therefore included in this issue, some of the strategies taken up at the national as well as regional levels. As a matter of fact, measures have been advanced by the countries in the Southeast Asian region to enhance the fishery resources which include the deployment of artificial reefs, installation of fish aggregating devices as well as fish enhancing devices, promotion of stock enhancement, and development of fish refugias and marine protected areas. Specifically, the creation of fish refugias has been recognized as a strategy in cases where the natural refuges no longer exist since refugias could act as effective barriers against recruitment failure.

It is therefore with much confidence that SEAFDEC continues to maintain the resources-based equilibrium in the Southeast Asian region. Once the supply and demand for food fish is well-balanced and with the capital in the food bank thriving, then fisheries would be one sector that could also take care of food security for the future generations.

Errata

In the article on **Towards Sustainable Community-based Fishery Resources Management: The Tagal System of Sabah, Malaysia (Fish for the People Vol. 7 No. 3 (2009))**, the following has been omitted in the References: Wong, Jephrin Zefrinus. 2008. Pers. Comm. The Tagal System of Malaysia.

We regret that in the same article, the following name has been omitted as the main author: **Jephrin Zefrinus Wong**

Mr. Jephrin Zefrinus Wong is the Principal Assistant Director, Department Fisheries Sabah, Kota Kinabalu, Malaysia.

The proper citation therefore of the said article should read: Wong, et al. 2009, and the corresponding reference should read:

Wong, J.Z,. Sujang, A.B. and Etoh, S. 2009. Towards Sustainable Community-based Fishery Resources Management: The Tagal System of Sabah, Malaysia. *In:* Fish for the People Vol. 7 No. 3. Southeast Asian Fisheries Development Center. Bangkok, Thailand; pp 18-23

FISH for the PEOPLE is a special publication produced by the Southeast Asian Fisheries Development Center (SEAFDEC) to promote sustainable fisheries for food security in the ASEAN region.

Shellfish collected from the coastal waters of Rayong Province in Thailand (Photo: Akito Sato)

Fishery Resource and Habitat Rehabilitation:
Improving the Productivity of Tidal Flats

Akito Sato and Mayumi Tamura

This article which was presented at the Second Meeting of the Regional Advisory Committee on Fisheries Management in Southeast Asia (RAC) convened by SEAFDEC in Bangkok, Thailand in September 2009, introduces the functions of tidal flats, provides views on diagnosing tidal flats as well as countermeasures for rehabilitation, and presents examples of case studies in Japan based on the "Guideline for Improving the Productivity of Tidal Flats (February 2008)" compiled by the Fisheries Agency of Japan. It is envisaged that making known such useful information on the conservation of tidal flats, would boost the efforts of the Southeast Asian countries in improving the productivity of their respective tidal flats.

Functions and Values of Tidal Flats

Tidal flats, also sometimes known as coastal shallow sandy/muddy seashores, are geographical features formed by piles of mud and/or sand at the bottom of coastal sea waters (**Fig. 1**). In many cases, the biodiversity of tidal flats are high, encompassing a large number of marine resources such as shellfishes, crustaceans and juveniles of fishes. In fact, many research reports have indicated that flatfishes thrive in coastal shallow sandy seashores in a bay during their juvenile stage.

Tidal flats have multiple functions such as fishery production, water quality purification, biodiversity support, and provider of waterfront amenities for people. Among the tidal flats' functions, the functions related to "water quality purification" and "biodiversity support" defer in a tidal flat with abundant shellfishes and in a tidal flat with few shellfishes.

Fig. 1. Landscape of a typical tidal flat in Japan
Photo: Guideline of the Productivity of Tidal Flats, Fisheries Agency of Japan.
(Source of succeeding photos is also "The Guideline")

It should be noted that the value of a tidal flat could be determined by its fishery production, such as the amount of bivalves. In particular, bivalves are typical fishery resources in tidal flats in Japan, where the tidal flats are being managed in order that bivalves can thrive and the productivity of tidal flats could be improved or maintained.

The aforementioned Guideline illustrates the value of the functions of Ishiki tidal flat located in an area of 10 km^2 at Mikawa Bay of Aich Prefecture as an example of typical tidal flats in Japan. At first, the value of its "Fishery Production" function is worth five billion yen/year. Included within this value, is the production from laver (*Nori*) aquaculture which is worth two billion yen/year. Every year the laver production from Ishiki tidal flat is about 200 million pieces by board paste.

In addition, the value of short-necked clam is worth one billion yen/year, from production of 4000 tons/year, while the value of its nursery function is about two billion yen/year, considering that shrimp production reaches 70-100 tons/year and other aquatic species such as flatfish, mud crab and goby are also being caught. Moreover, the value of the "Water Quality Purification" function is worth about four billion yen/year. Although the total amount of productivity evaluated in this example may not be so important, various important values of tidal flats as well as seaweed beds and coral reefs, could be well understood. Furthermore, since the values of tidal flats are strongly influenced by the productivity of the fishing grounds, it is necessary to manage fishing grounds so that the productivity is improved or maintained.

Basic Concepts in Diagnosing Tidal Flats

The basic concept of investigating the environmental conditions of tidal flats focuses on two important diagnoses, *i.e.* diagnosis of the fishing grounds (diagnosing the physical/biological environments on site) and diagnosis of the fishery resources (diagnosing the conditions of the bivalve resources, if necessary including other important fishery resources). These two diagnoses should be done in order to clarify the factors that could possibly obstruct the productivity of tidal flats and to develop the necessary countermeasures for their conservation and rehabilitation.

Diagnosing the fishing grounds

Physical environment of tidal flats

The distribution of bivalves in tidal flats is strongly affected by the elevation of topographies and changes in the sediments. Alterations of the topographies and sediments of tidal flats generally occur due to the changes of the flow of water current and supplies of sand/mud brought about by the influence of natural conditions or human activities. In particular, changes in the sediments including the varying particle size distributions and silt contents brought about by the accumulation of floating mud, drift sand and stiffened sea bottoms, affect not only the physical environment habitat of the bivalves but also their feeding environment. Therefore, when an increase in mud or a stiffened sea bottom leads to a decrease in the bivalve resources, such changes (*e.g.* supplies of mud and current of water flow) should be given attention. In particular, the experience in Japan could be referred to by the Southeast Asian countries considering that there are lots of tidal flats in the region where the supply of sand from rivers has decreased due to construction of dams resulting in the worsening of the physical environment of such tidal flats.

Biological environment of tidal flats

The primary production in tidal flats is contributed mainly by microalgae at the sea bottom, phytoplankton and large-scale seaweeds. In particular, benthos at the sea bottom which influence microalgae and phytoplankton play important roles for the survival and growth of bivalves. The distribution of benthos depends greatly on the characteristics of the sea bottoms, which are especially affected by the flow of water current such that when there is little current flow in locations where silt contents or sludge accumulate, the variety of the species and biomass of benthos could decrease. On the other hand, if the current flow is excessively rapid, the sediments at the sea bottom become unstable resulting in the possible decrease of the variety of species and biomass of the benthos. Therefore, in order to maintain the fishery resources or biodiversity, promoting a balance between the sediment stability and current of the water flow should be given attention.

Diagnosing the bivalve resources

Tidal flats could encompass few juvenile bivalve resources due to less number of drifting larvae or when the settlement of the larvae on the sea bottoms could not occur or when the larvae decrease after settlement. The presence of few drifting larvae could be mainly because of insufficient parent bivalve or interceptions of the drifting larvae network within the life cycle of bivalves (**Fig. 2**, **Fig. 3**). The reasons for the unsettlement of larvae or depletion of juvenile bivalves could be silt accumulation, low oxygen content of the water or high water temperature. On the other hand, in the case of tidal flats having sufficient juvenile bivalve resources but production is still low, it is necessary to identify the principal causative factors such as predators or extreme environmental changes. If there are no conspicuous factors, the reasons could be considered as unsuitable sediments, inadequate water quality, and low oxygen content in the water, among others.

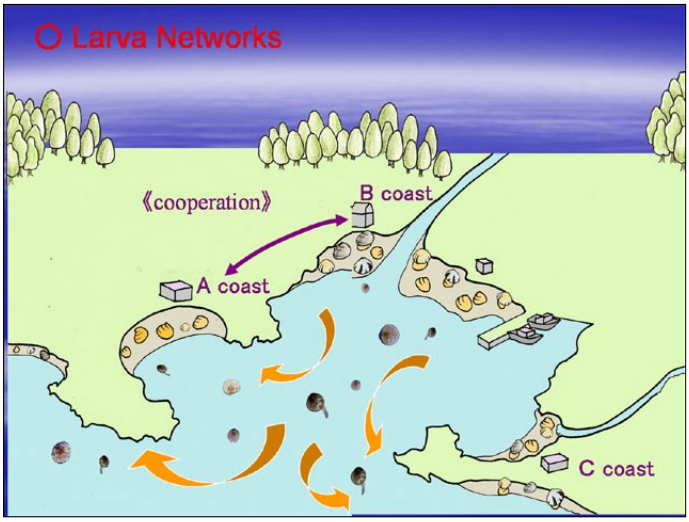


Fig. 2. Networks of bivalve larvae *(Source: The Guideline)*

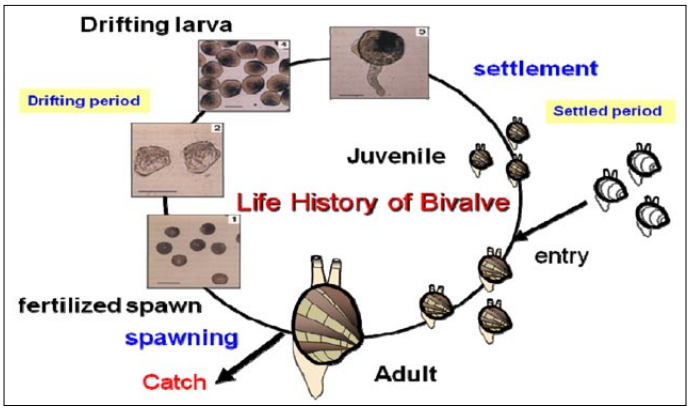


Fig. 3. Life History of bivalves *(Source: The Guideline)*

Countermeasures for Improving the Productivity of Tidal Flats

The larvae networks (in wide-ranging waters)

The larvae of bivalves drift for several days and sometimes spread to wide areas according to the natural and geographic conditions of the wide-range of waters. To maintain a sufficient supply of bivalve larvae in such case, and to increase stable bivalve production in tidal flats, not only the countermeasures within each tidal flat but also the integral countermeasures for the adjacent tidal flats should be promoted from the point of view of wide-ranging larvae networks.

Improvement of the environment of fishing grounds

Installation of bamboo fences and covered nets in fishing grounds

It is necessary to improve relevant and nearby areas that also influence the life cycle of bivalves, such as the areas where the parent bivalves as sources of the larvae supply inhabit in high density, the larvae settlement areas as well as the breeding areas of juvenile bivalves.

In general, the settlement rate of drifting larvae could be increased through the installation of bamboo fences (**Fig. 4**), while the survival ratio of juvenile bivalves could be improved by the installation of covered nets (**Fig. 5**). Nevertheless, such bivalve conservation management has to take into consideration the season and the specific sites of the installations as well as maintenance, because installation of bamboo fences and covered nets may also have negative influence on the settlement of the drifting larvae and the survival of juvenile bivalves due to the attachment of periphytons on the bamboo fences and covered nets or the accumulation of sediments.

Fig. 4. Bamboo fence installed to promote settlement of drifting larvae *(Photo: The Guideline)*

Fig. 5. Installation of covered nets to protect the juveniles of short-necked clams *(Photo: The Guideline)*

Sand capping, waterway dredging and cultivation of sea bottoms

Countermeasures such as sand capping of sea bottoms are often adopted to improve the muddy or stiffened sea bottoms. By covering an area with favorable sand, the sea bottom that has become muddy could be improved. On

the other hand, in cases where there is little exchange of water current flow, artificial waterways could be dredged to provide channel for the nutrients to flow or to prevent the accumulation of drifting mud on the fishing grounds.

Furthermore, interfering with the conditions of the fishing grounds by cultivating the sea bottom would improve its environmental conditions considering that this would loosen the hardened sediments, promote removal of unwanted algae, deoxidize the beds near the sea bottom surface, and dissolve the nutrients necessary for the growth of the bivalves.

Countermeasures against predators and harmful microorganisms

Since the effect of predators such as the manta ray as well as the sea snail, *Neverita didyma* and starfish on the bivalve resources could vary according to the location and season, it is necessary to gather information about the influence of such predators and the effect of the countermeasures in neighboring waters. On the other hand, harmful microorganisms could prey on the bivalves indirectly through the sediments or waters in the tidal flats. In particular, large concentration of harmful microorganisms (algal bloom or red tide) in the waters could affect the bivalve resources. In order to eliminate harmful microorganisms from the sediments of the sea bottoms, countermeasures by manually removing them and cultivation of the sea bottoms are conducted by the Japanese fishermen. As for the occurrence of harmful microorganisms in the waters such as "red tide", although studies on countermeasures are advancing, still there are no practical measures to prevent the occurrence of such phenomenon in advance.

Fishing activity management

In promoting fishing activity management, two factors should be taken into consideration. One is "entry management" which could be achieved by preventing the over-fishing of parent bivalves in order to increase the larvae supply, and "growth management" by preventing over-fishing of immature or young adult bivalves. Entry management is aimed at allowing parent bivalves to spawn in fishing grounds. On the other hand, growth management is aimed at preserving immature or young adult bivalves and securing their growth up to the later stage when the larvae could be considered as parent bivalves and capable of spawning sufficiently. In the case of growth management, the density of the parent bivalves and the degree of their maturity should be taken into consideration.

Handy Method of Monitoring Bivalve Distributions

In Japan, distribution survey of bivalve resources such as the short-necked clam is one of the most important surveys conducted to advance resources management. Distribution surveys are usually implemented in the same sites and the same period every year, even if a distribution survey done only once could result in sufficient data, because changes of the bivalve resources could be visually monitored. Distribution surveys of bivalve resources could be easily implemented, provided that manpower and several handy tools (**Fig. 6**) are readily available for sampling and analyzing the samples. In Kumamoto Prefecture located in the southwest of Japan, distribution surveys for bivalve resources are conducted every year at each fishing ground in tidal flats with the cooperation of the fishermen, staff of fishery research stations and staff of local government officers (**Fig. 7**).

The tools for sampling include a square frame, small shovel, sieve, plastic bag, shoulder bag, and neutral formalin (to be used in case storing of samples for later analysis is necessary). In addition, the tools for analyzing samples as in the case of short-necked clam distribution survey conducted at the Kumamoto Prefecture, include a sieve, Petri dish, pair of tweezers, and pair of calipers. For analyzing the samples, after selecting short-necked clams from the samples and measuring the length, alive and dead samples are determined by smashing the shells. Only data from live samples are considered, and from such samples, the distribution density and length distribution of bivalves

Fig. 6. Survey tools for sampling and analyzing samples
(Photos: Resource Management Manual of Short-necked Clams in Kumamoto Prefecture, Kumamoto Fisheries Research Center)

Fig 7. Procedures in sampling short necked clams *(Photos: Resource Management Manual of Short-necked clams in Kumamoto Prefecture, Kumamoto Fisheries Research Center)*

in certain sampling points are calculated to obtain the basic data for resources management.

Although bivalve resources may be only one of the marine resources in tidal flats, a distribution survey of bivalves is important considering that bivalve production could serve as a typical index of productivity of tidal flats, and distribution survey could be relatively an easy method to undertake.

Management of the Matsuo Tidal Flat: An Example of Management Activities

Description of the Matsuo tidal flat

Matsuo District in Kumamoto Prefecture is a small fishing village facing the Ariake Sea, where about 120 fishermen are engaged in part-time farming and part-time fishing. The main fishing activity in the district is gathering bivalves mainly the short-necked clams. In a tidal flat that expands from river estuaries, short-necked clam fishery is carried out only in sand-capped fishing grounds of about 25 hectares which have been improved by the local government in the late 1980s and early 2000s (**Fig. 8**). In the Matsuo District, the productivity of short-necked clams is maintained every year through appropriate management activities conducted by the fishermen themselves.

Trend of short-necked clam production

The history of tidal flat management adopted by the fishermen of Matsuo Fishery Cooperative in the Matsuo District and the trend of short-necked clam production are illustrated in **Fig. 9**. The Matsuo tidal flats had been

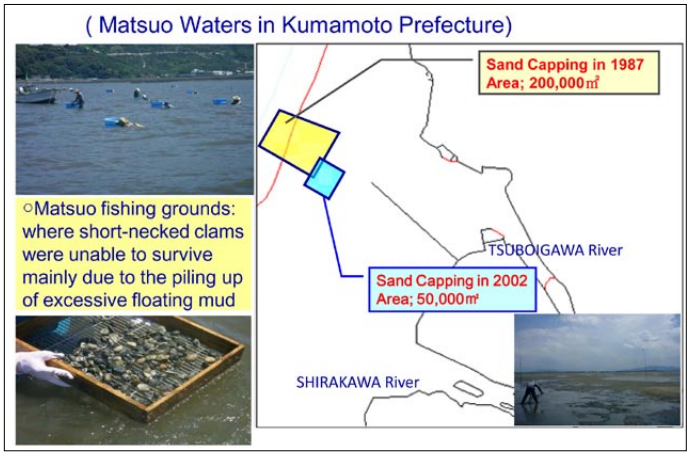


Fig. 8. Sand-capped area in Matsuo tidal flats
(Sources: Kumamoto City and Matsuo Fishery Cooperative)

favorable fishing grounds of short-necked clams for a long time. However, production of short-necked clams had decreased during the 1980s mainly because of the outflow of drifting mud from the rivers as well as from other tidal flats near the Ariake Sea. As an initial remedy, the fishermen transplanted mother clams in the tidal flats to increase the short-necked clam resources, but the resources did not recover. Recognizing that the environmental conditions of fishing grounds for short-necked clams had worsened, the fishermen initiated a tidal flat capping in 1982 using sand, which in effect had been continued for a few years. However, during the 1990s there were still almost no production of short-necked clams, therefore, as their next self-managed action to improve the productivity of the tidal flats, the fishermen in Matsuo implemented management activities in the sand-capped fishing grounds. As a result, from 1999, the next year of implementation of the fishermen's self-

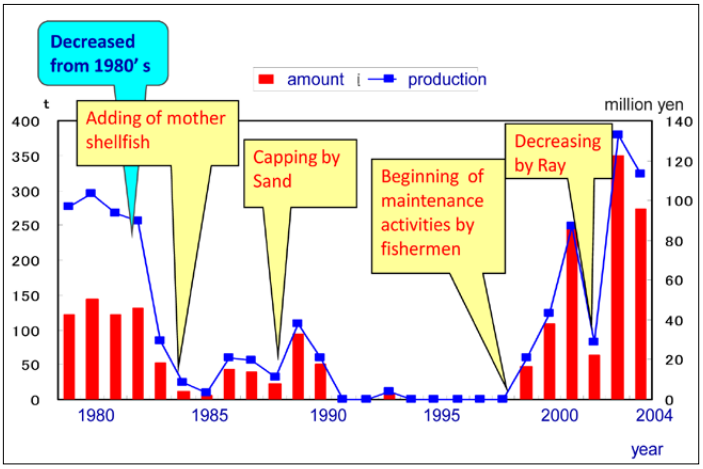


Fig. 9. Trend of short-necked clam production in Matsuo tidal flats *(Sources: Kumamoto City and Matsuo Fishery Cooperative)*

management activities that included installation of bamboo fences and placement of covered nets (**Fig. 10a** and **Fig. 10b**), production of short-necked clams had increased.

In the midst of the fishermen's intensified management efforts, the short-necked clams in Matsuo's improved fishing ground were devastated by manta rays in 2002. It was not initially known that the rays ate the short-necked clams until the fishermen caught a number of rays and discovered a lot of short-necked clams in their stomach. The fishermen therefore, started to catch the rays to protect the short-necked clam resources. Since then, the resources of short-necked clams have recovered and production of the clams has been sustained to a level of about 300 tons per year.

Fishing ground management by fishermen

In the Matsuo District, installation of bamboo fences to promote the settlement of drifting larvae, installation of covered nets to protect the juvenile short-necked clams and transplantation of juvenile bivalves to disperse the high density of juvenile short-necked clams, have been implemented as a fishing ground management by the fishermen themselves. After the rays appeared, countermeasures were soon taken to reduce the pressure by catching the rays. Furthermore, fences using poles were installed to protect the coastal fisheries from floating driftwood and garbage flowing from the rivers. In addition, the fishermen participate in patrolling the fishing grounds to prevent poaching of the bivalves.

Resources management activities

The Fishery Cooperative of Matsuo has been strengthening its efforts in bivalve resource management after the implementation of the fishing ground management and observing that the resources have started to recover. Concretely, field surveys on the distribution of short-necked clam resources have been carried out to assess the status of the resources at important periods such as before the start of fishing activities and during the period of spawning in spring and autumn of each year. Moreover, fishing activity policies and plans for a year are decided among the fishermen based on the results of the field surveys.

Such procedures have motivated the fishermen in voluntarily managing the fishing grounds by themselves, without being compelled by the Fishery Cooperative and the Kumamoto City Government. The resources management effort of the Matsuo fishermen could be considered a typical example of successful resource management activities which are carried out by the fishermen, resulting in the improvement of the fishery resources through proper fishing ground management activities.

Fig. 10a. Bamboo fence installed to promote settlement of drifting larva *(Source: Kumamoto City and Matsuo Fishery Cooperative)*

Fig. 10b. Covered net to protect the juvenile short-necked clams *(Source: Kumamoto City and Matsuo Fishery Cooperative)*

Change in fishermen's attitude

Fishermen in the Matsuo District have recognized that fishing ground management is an important aspect of fishery management together with resources management. Through the implementation of management activities, the fishermen became aware of the fact that the favorable environments of short-necked clam fishing grounds are developed by the short-necked clams themselves. When there are less short-necked clams in tidal flats, the once favorable fishing grounds are changed into waste grounds, but it is possible to support favorable fishing grounds through the efforts of fishermen within their capabilities so that short-necked clams could continue to breed.

Discussion

1. Tidal flats as well as seaweed beds and coral reefs have various important functions and values, and the values of tidal flats are strongly influenced by the productivity of the fishery resources.
2. "Fishery resources management" and "Fishing grounds management" are the two wheels of the same vehicle for improving the productivity of tidal flats.
3. Foremost, the fishermen have been using their fishing grounds, showing that the presence and activities of fishermen are indispensable for the effective management of fishery resources and fishing ground in tidal flats.

Way Forward

1. Considering that the coastal environments are becoming worse year by year, the need to modify policies from being protection-oriented to being regeneration-oriented has become an urgent concern.
2. The aforementioned bivalve resource distribution survey could be a tool which the countries in the Southeast Asian region could adapt in assessing their respective tidal flats, and is relatively easy to implement.
3. Management of tidal flats mainly by the fishermen could be feasible by implementing an activity first at one model site with the cooperation of administrators and researchers who have interest in the management activities of the pilot site in each country.
4. SEAFDEC intends to support a program on the rehabilitation of fishery resources and their habitats/ fishing grounds starting in 2010 under the Japanese Trust Fund V.

Acknowledgement

A number of researchers led by Dr. Naritoshi Cho, Ms. Rena Shibata, and Dr. Satoshi Watanabe of the National Research Institute of Fisheries Science, Fisheries Research Agency were in charge of the development and completion of the Guideline. In particular, the valuable suggestions and cooperation of the members of the committee led by Dr. Akinori Hino from the University of Tokyo during development of the Guideline are very much appreciated. The finalization of the Guideline could have not been made possible without their assistance. Furthermore, much gratitude also goes to the Matsuo Fishery Cooperative of Kumamoto Prefecture and Kumamoto City led by Mr. Masaaki Kuroda and Mr. Kenji Nakaguma for advancing and positively supporting the management activities of the Matsuo fishermen as well as for their valuable information and cooperation during the field surveys conducted in Kumamoto.

References

The Guideline for Improving the Productivity of Tidal Flats (in Japanese), Fisheries Agency of Japan (2008)

The Resource Management Manual of Short-Necked Clams in Kumamoto Prefecture II (in Japanese), Kumamoto Fisheries Research Center (2007)

Resource Management in Fishery Cooperative Matsuo (in Japanese), Fishery Cooperative Matsuo (2006)

Akito S, Mayumi T, Naritoshi C., Rena S. and Satoshi W. The Guideline for Improving the Productivity of Tidal Flats (in Japanese), in Proceedings of the 7th National Technology and Research Symposium for Improving Fishery Infrastructure (Oct. 2008, Miyazaki Pref. in Japan)

About the Authors

Mr. Akito Sato is the Assistant Trust Fund Program Manager at SEAFDEC Secretariat based in Bangkok, Thailand. Before his tour of duty at SEAFDEC and while working at the Fisheries Agency of Japan, Mr. Sato was in charge of the development of the Guideline.

Ms. Mayumi Tamura is based at the Fisheries Agency of Japan in Tokyo, Japan.

Sustainable Fisheries Development through Cooperative Strategies for Long-term Food Security: The ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security Towards 2020

Chumnarn Pongsri

Through the years, SEAFDEC has always sustained its support for the ASEAN countries by implementing programs that address various issues towards the development of sustainable fisheries in the ASEAN region.

The formal collaboration between SEAFDEC and the ASEAN could be traced back in 1998 when the ASEAN-SEAFDEC Fisheries Consultative Group (FCG) was established to pave the way for the implementation of multi-disciplinary fisheries programs for the sustainable development of fisheries in the ASEAN region. Three years later, the adoption of the ASEAN-SEAFDEC Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region in 2001 had strengthened the support of SEAFDEC to the ASEAN countries through the implementation of projects and activities aimed at intensifying the contribution of fisheries to food security of the region. The collaborative mechanism between SEAFDEC and the ASEAN was later boosted when the ASEAN-SEAFDEC Strategic Partnership (ASSP) was formalized in 2007.

After more than a decade of intensified collaboration between SEAFDEC and the ASEAN, significant progress has been attained by the ASEAN countries in promoting sustainable fisheries and in improving the people's livelihood leading towards food security. The existing fisheries collaborative mechanism under the aforementioned cooperative strategies is therefore being advanced for long-term sustainability and food security. In order to sustain such momentum, SEAFDEC is planning to organize the ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security Towards 2020 in June 2011.

The ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security Towards 2020

The ASEAN-SEAFDEC Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region which were adopted during the Millennium Conference in November 2001 have served as policy framework that steer the ASEAN member countries towards sustainable development and enhanced contribution from fisheries to food security. The changing global economic scenario and the deteriorating state of the region's fishery resources during the past decade, however, have necessitated the need for SEAFDEC and the ASEAN to converge again in order to assess the progress and achievements in the implementation of programs under the 2001 Resolution and Plan of Action in the ASEAN region as well as to develop the next decade regional direction.

To be jointly organized by SEAFDEC and the ASEAN and hosted by Thailand, the Conference is planned to be held in June 2011 in Bangkok, Thailand. The Conference is intended to come up with the "Decade Resolution and Plan of Action on Sustainable Fisheries for Food Security in the ASEAN Region (Towards 2020)" to be used as policy principle in achieving sustainable fisheries for food security in the coming decades. The Conference also aims to create enhanced awareness on issues related to sustainable fisheries and food security through the participation of the ASEAN countries in the Conference.

About the Author

Dr. Chumnarn Pongsri, Ph.D., is the new Secretary-General of SEAFDEC succeeding Dr. Siri Ekmaharaj who completed his four-year term of office as Secretary-General on 30 September 2009. Dr. Chumnarn has a vast experience in the various disciplines of fisheries and aquaculture. Before joining SEAFDEC, he occupied the position of Expert in Ecology at the Department of Fisheries (DOF) of Thailand. Having been equipped with master's degrees in aquaculture and public administration in renowned universities in Thailand as well as a doctoral degree from the University of Wales in the U.K., Dr. Chumnarn has contributed in various ways, to the achievements of the DOF towards attaining sustainable development of the country's fisheries industry. Dr. Chumnarn had also for some years worked for the Mekong River Commission Secretariat as Director of its Environment Division and as a Member of the Board of Advisers for the Greater Mekong Sub-region Academic Research Network. Moreover, Dr. Chumnarn has also served as Secretary to the Permanent Secretary of the Ministry of Agriculture and Cooperatives of Thailand.

Modifying the Drifting Fish Aggregating Devices to Mitigate Sea Turtle Mortality: A SEAFDEC Initiative

Isara Chanrachkij, Somboon Siriraksophon and Anurak Loog-on

This article is based on the Preliminary Report on the Study of Ghost Fishing Phenomena by Drifting Fish Aggregating Devices (DFADs) in the Eastern Indian Ocean, which aimed to assess the accidental mortalities of marine animals around the Drifting FADs in the Eastern Indian Ocean. The study was conducted from December 2002 to January 2003 during the shipboard purse seining cruise of the M.V. SEAFDEC, where data on the accidental catches of marine mammals and other marine fishes were collected from drifting and abandoned FADs. Results of the study indicated that marine turtles comprised the highest number of incidental catch from the drifting FADs followed by marine fishes such as leather jackets, triple tails, rainbow runners, sea chubs, wahoo, skipjack, barracuda, and remora as well as sharks and porpoises.

Tuna resource is one of the most important marine resources in the world. In 2006, FAO recorded about 6.5 million mt of tunas, bonitos and billfishes produced around the world. Purse seine is the major fishing gear used for catching tunas in the countries' EEZs as well as in the high seas, where tuna purse seine fishers apply various techniques to maximize their catches. These include fishing the free swimming tunas when tuna schools are feeding near the sea surface; fishing tunas in association with porpoises but this has been abandoned to protect the dolphin population; and using drifting objects such as drifting flotsams, drifting logs, drifting garbage, and the like, that could aggregate the target fish species.

Although considered a difficult operation, fishing the free swimming tunas does not produce any unwanted or incidental catch. In the case of fishing with porpoises, the Inter-American Tropical Tuna Commission (IATTC) has imposed a sanction against the importation by the US of tunas caught with porpoises. The only option left for the tuna industry is the use of fish aggregating devices (FADs)[1] to attract schools of tunas and maximize tuna catch. FADs may be drifting (DFADs) or anchored (AFADs), which was originally known in the Philippines as *payaos*.

Issues and Concerns

The Eastern Indian Ocean covers the fishing area from Chagos Archipelago in the Maldives to Western Sumatra in Indonesia (**Fig. 1**). In the world's tuna fisheries, the Eastern Indian Ocean is considered less significant than the Western Indian Ocean. While the latter accounts for about 18% of the world's total tuna production, the former contributes only about 7%. However, the Eastern Indian Ocean (Area 57) encompasses an important fishery resource for exploitation by some Southeast Asian countries such as Thailand, Myanmar and Indonesia.

During the last decade, most tuna purse seiners operating in Area 57 were mainly tuna research vessels including those from Thailand and Japan. Drifting Fish Aggregating Devices (DFADs) and *payaos* have become the most important tools for gathering tuna schools in Area 57 because free-living tuna schools are rarely sighted in this part of the Indian Ocean.

Most research vessels operating in Area 57 therefore make use of the DFADs and *payaos* for their tuna purse seine fishing trials. During such fishing trials however, juveniles of yellowfin tuna were also observed to aggregate near the

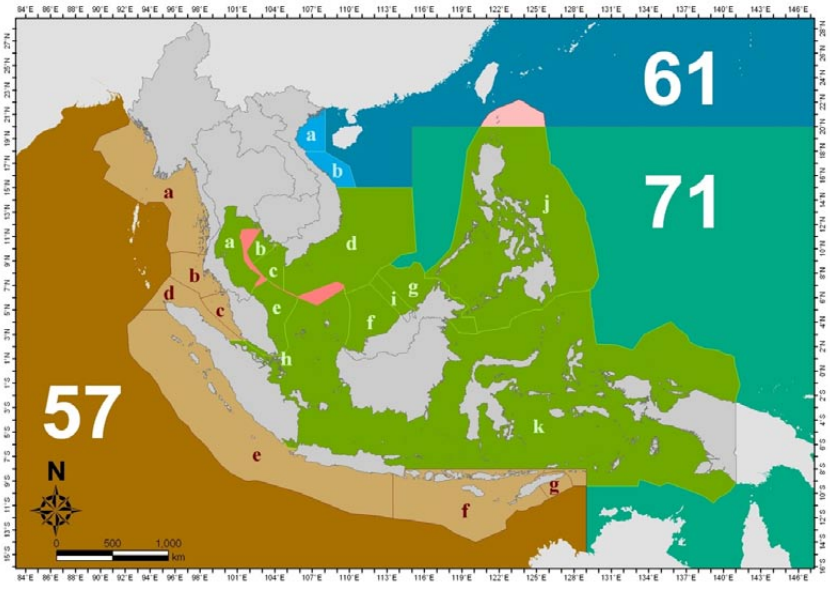


Fig. 1. Eastern Indian Ocean indicated as FAO Fishing Area 57

[1] FAO defines fish aggregating devices (FADs) as artificial or natural floating objects placed on the ocean surface, often anchored to the bottom, to attract several schooling fish species underneath, thus increasing their "catchability".

payaos and were eventually caught in the fishing operations, making the use of *payaos* a non-selective technique.

Once abandoned or lost, the DFADs and *payaos* in the ocean surface could enhance ghost-fishing[2] together with lost or abandoned fishing gears. Reports have indicated that the most common fishing gear known to ghost fish are the gill nets and crustacean/fish pots. Other fishing gears and their parts (such as trawls, seines and long-lines) abandoned or lost in the sea, could also get involved in ghost-fishing adding to the environmental problems in the oceans. Abandoned purse seine can also become a ghost gear while the *payaos* used in tuna fishing operations can also facilitate ghost fishing due to the nature of their design and construction.

DFADs Used by SEAFDEC

One of the main functions of SEAFDEC is to develop responsible fishing technologies and practices for the sustainable use of the marine fishery resources in Southeast Asia, which include the development of responsible tuna and skipjack fisheries. Since 1993, the SEAFDEC Training Department (TD) has been conducting tuna purse seine fishing operations in the Eastern Indian Ocean specifically in the waters adjacent to the fishing grounds of Thailand (**Fig. 2**) using the M.V. SEAFDEC (**Fig. 3**). Recognizing the fact that schools of free swimming tunas are rarely found in the Eastern Indian Ocean, SEAFDEC also makes use of aggregating techniques by deploying FADs to attract the schools of tunas.

From the point of view of the tuna fishing industry, the use of fish aggregating devices (FADs) is necessary to achieve

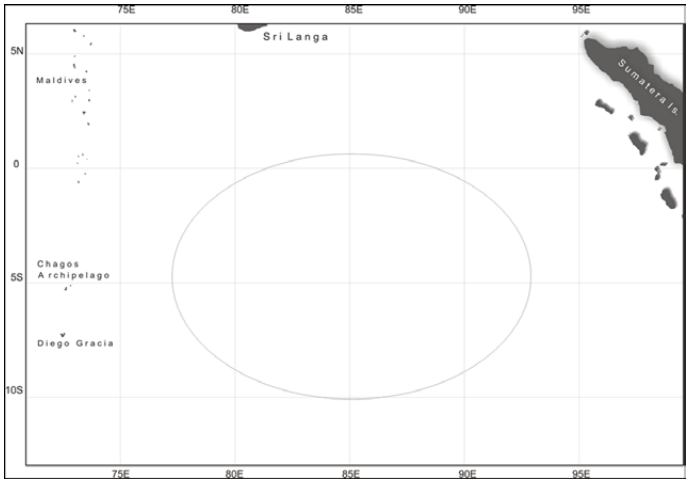


Fig. 2. Fishing area in Eastern Indian Ocean where SEAFDEC/TD conducted tuna purse seine operations from December 2002 to January 2003

[2] Ghost-fishing refers to the ability of fishing gear to continue fishing even after all control of the gear has already been abandoned or lost by the fishermen.

Fig. 3. The M.V. SEAFDEC (tuna purse seine research/training vessel) used by SEAFDEC/TD to conduct tuna purse seine operations in the Eastern Indian Ocean

maximum tuna catch. Although the use of FADs is mainly aimed at enhancing the aggregating performance, the rationale behind the development of the FADs is anchored in two major concepts. In the first concept, some sessile organisms such as barnacles could attach to some parts of the FADs, where primary consumer fishes gather around resulting in the establishment of pelagic habitats that serve as source of food for the tunas. Secondly, the enmeshed and entangled small preys at the net part of the FADs serve as baits for other predator fishes that swim around the FADs. Although the latter concept could also enhance the development of pelagic habitats, accidental deaths of unwanted fishes could occur. Nonetheless, non-intentional or unwanted catches are mostly realized from ghost fishing by the abandoned FADs, considering the many reports which indicated that about 10-20% of FADs are lost every year in the open sea.

During the tuna purse seine fishing operations of SEAFDEC/TD, FADs were used to attract the schools of fish. Trials on the appropriate types of FADs were carried out, namely: the anchored fish aggregating device (AFAD) and drifting fish aggregating device (DFAD). In terms of accessibility, the DFAD was more advantageous than the AFAD because the distance of the fishing ground (300 nautical miles from port of Phuket in Thailand) makes maintenance and monitoring of the AFAD inconvenient. Furthermore, the anchor line of the AFAD could be cut or lost during storms and strong water current. Thus, SEAFDEC/TD opted to use the DFAD for gathering schools of tuna and skipjack in the deep and vast Eastern Indian Ocean.

The DFAD used by SEAFDEC was patterned after the original design for the Japanese purse seine vessel, the R.V. Nippon Maru during its tuna fishing and research operations in the same fishing ground. From such original DFAD design, two types of DFADs were designed by

SEAFDEC/TD such as the raft type and curtain type, which have the same purpose of maximizing the aggregation of large schools of tuna and skipjack.

The raft type is square shaped, 2.4x2.7 m (**Fig. 4**). The square frames of the raft as well as the supporting bar of the frames are made of iron pipes. Bamboo poles are tied together with the frame of the raft, and purse seine floats are fixed at each corner to support buoyancy. Covered by a sheet of nylon net or polyethylene, this DFAD design is durable and convenient to be carried on board the vessel and can be redeployed many times during the fishing period from 8 to 10 months.

The second type of DFAD is the curtain type, also using bamboo poles tied together (**Fig. 5**). Supported by purse seine floats for buoyancy, the floating part is also covered by sheets of nylon net as in the raft type. Although this design could be more fragile than the raft type, its construction is easier and more convenient particularly when done onboard fishing vessels with limited working space.

Both types of DFADs are fixed with purse seine net panels, also known as "skirts" and tightened below the floating part. The skirt panel is made from recycled purse seine net sheets or trawl nets. The lower edge of the skirt net is tightened with weights, *e.g.* chain, concrete or old steel wires. Four skirt net panels are set under the raft type of the DFAD where each side is attached with a sheet. For the curtain type, only the skirt net panel is installed. Radio buoys or GPS positioning buoys are attached with all DFADs to monitor their direction and to determine their positions during retrieval after drifting in the ocean for at least one month.

In the case of the SEAFDEC DFADs, after having been positioned in the Eastern Indian Ocean for one month, monitoring was conducted to determine and record the data of the species caught including the composition, length, weight and number of accidental catch, and also to determine the relative proportion between the accidental and the target catch by the DFADs.

Modification of DFADs by SEAFDEC

During the SEAFDEC tuna purse seine trial operations, it was observed that not only tunas aggregate near the DFADs but other marine animals as well, such as several species of marine turtles (mostly the Hawksbill and Ridley's turtles) and unwanted fishes that were accidentally killed when they become entangled in the skirts of the DFADs. Thus, it was necessary to modify the designs of the DFADs used by SEAFDEC in line with its efforts to conserve the marine turtles in the Southeast Asian region.

For the fishing season in 2002-2003, SEAFDEC improved the aggregating efficiency of its DFADs by modifying the accessories and skirt parts, replacing the net skirt sheets with Spanish mackerel gillnet materials that were no longer used. Such modification was aimed at enmeshing the small fishes around the DFADs, which could serve as forage of

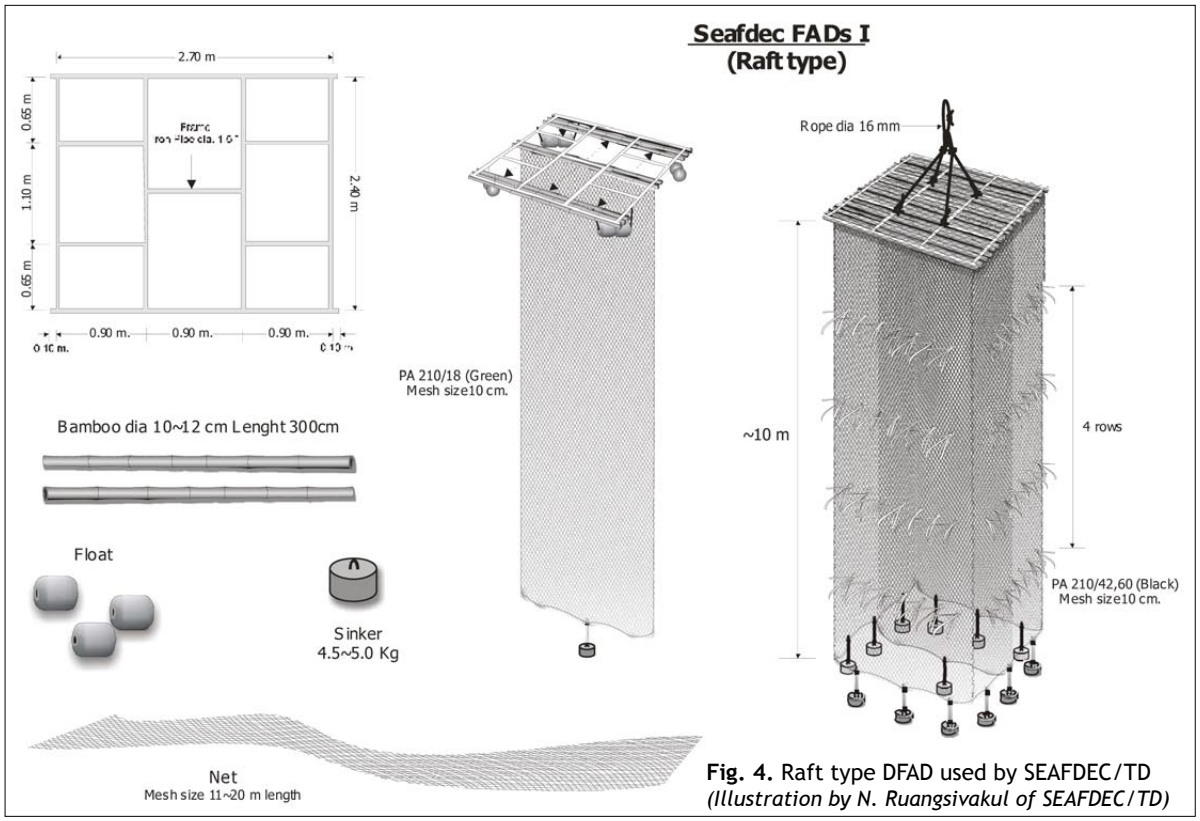


Fig. 4. Raft type DFAD used by SEAFDEC/TD
(Illustration by N. Ruangsivakul of SEAFDEC/TD)

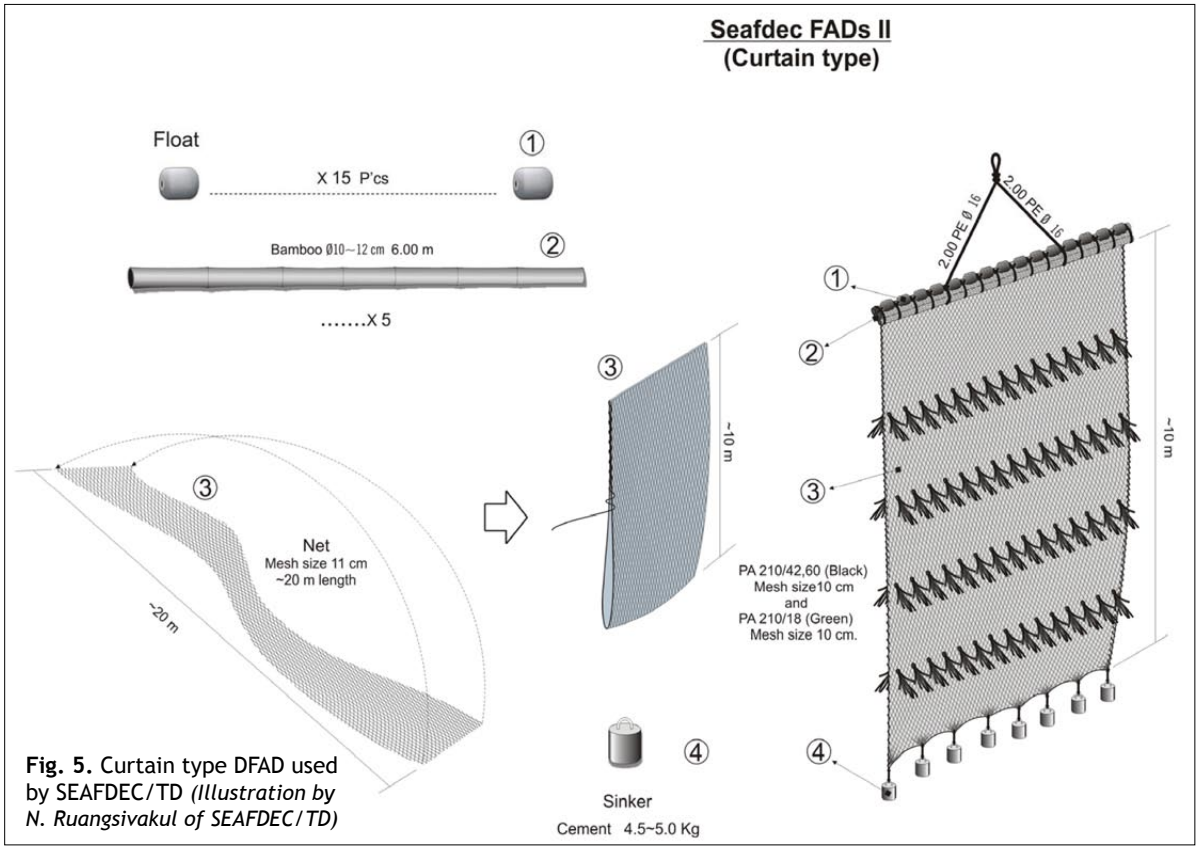


Fig. 5. Curtain type DFAD used by SEAFDEC/TD *(Illustration by N. Ruangsivakul of SEAFDEC/TD)*

other small fishes as well as enhance the aggregation of more small fishes around the DFADs and finally attracting more tunas and skipjacks to feed on the small fishes.

The modified SEAFDEC DFADs were deployed in the East Indian Ocean in December 2002 and after one month only 17 DFADs could be located and checked for fish schools while the other five (5) DFADs were lost in the ocean. The 17 SEAFDEC DFADs and another three (3) unidentified abandoned DFADs were detected visually and also by using hydro-acoustics equipment. The purse seine fishing operations conducted near the 11 SEAFDEC DFADs yielded a total catch of 54.4 tons of tuna and skipjack without any sea turtle incidental catch. In the area surrounding one SEAFDEC DFAD, the total catch of tuna and skipjack was 19.0 tons with the leather jackets as the only incidental catch. However, during the fishing trials, 11 sea turtles were sighted to have been entangled in abandoned DFAD nets and drifting garbage near the SEAFDEC DFADs.

During the whole fishing trials conducted by SEAFDEC, it was observed that 30 sea turtles were incidentally entangled by the three (3) SEAFDEC DFADs and three (3) unidentified abandoned DFADs. The 30 marine turtles comprised two main species, namely: Hawksbill (16), Ridley's turtles (5), and another 9 sea turtles which could not be identified for these were already in advance state of decomposition. The live sea turtles were immediately released into the sea after extricating them from the nets and other objects. As for the SEAFDEC DFADs, 11 marine turtles (2 Ridley's turtles and 9 Hawksbill) were incidentally entangled with the drifting garbage, of which five (1 Ridley's turtles and 4 Hawksbill) died before these could be released to the sea.

A worst incident occurred when a number of sea turtles were found entangled in three (3) unidentified abandoned DFADs that drifted with garbage in the ocean at Latitude 02º27´N to 02º29´N and Longitude 087º16´ E to 087º18´E. Seventeen sea turtles were entangled in the skirt nets of the abandoned DFADs, 14 of which were still alive but the other 3 were already dead. Since the live turtles seemed to be exhausted the crew of the M.V. SEAFDEC released them immediately without identifying the species. There were still at least 6 sea turtles that the SEAFDEC researchers could not disengage from the drifting garbage because the garbage was too heavy to be hauled up onboard the M.V. SEAFDEC.

Based on the experience of the SEAFDEC researchers during the M.V.SEAFDEC purse seine fishing trials in the Eastern Indian Ocean, mortality of sea turtles occurred in mainly two (2) processes. Firstly, mortality could occur during tuna purse seine operations when sea turtles stay around the DFADs and get entangled in the net parts. In some cases, sea turtles could survive for long period during the net hauling because the net circle is widely spaced. When the net is hauled up to the vessel and upon reaching the bunt part where the net circle is narrower, the entangled sea turtles could be rescued by carefully and manually extricating them

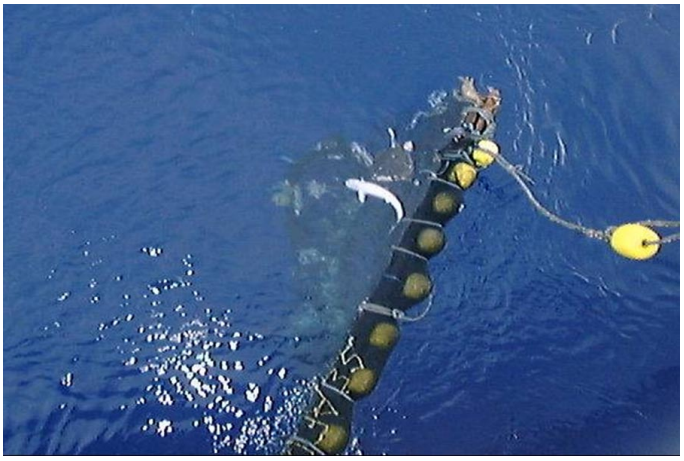
and immediately releasing them back to the sea. However, injuries could still happen when their flippers get entangled with the net twine during net hauling.

Secondly, mortality could also result when some body parts of the sea turtles, *e.g.* head, flipper or shell get entangled in the net skirt of the DFADs. Thus, modifications were made by SEAFDEC for its DFADs in order to minimize if not avoid mortalities of sea turtles during the tuna purse seine operations. As experienced by SEAFDEC researchers (A. Munprasit in 1992 and I. Chanrachkij in 2001) onboard the Japanese research vessel, the R.V. Nippon Maru during its fishing operations around their DFADs, no sea turtles were incidentally caught. The DFADs used by the R.V. Nippon Maru were also the raft type (3x3 meters, square shape, little bit bigger than the SEAFDEC design) with the net skirt made from nylon with bigger sized twine but seemed more rigid than the SEAFDEC design.

In order to reduce the mortality risks of sea turtles from tuna purse seine operations using DFADs, selecting the most appropriate rigid net material for the net skirt of DFADs should therefore be one of the major concerns. In addition to using big size twines of nylon material, Polyethylene (PE) twines could also be used for assembling the net skirt of DFADs. However, PE net twine could be less efficient in aggregating the bait fishes than with the nylon material because it would be difficult for the sessile organisms, *e.g.* barnacles to attach themselves on the net twine. Lately, the use of all materials for constructing drifting gillnets have been prohibited in putting together the AFADs or DFADs, consistent with the recommendation of the Indian Ocean Tuna Commission (IOTC), which indicated that tuna netting materials used to cover the DFADs should be replaced by other more functional and efficient materials. As a result, many tuna fishing operations no longer experience the presence of incidentally caught sea turtles in their DFADs (Delgado de Molina *et al*., 2005).

Another important cause of the mortality of sea turtles had been observed from lost and abandoned DFADs. Although most DFADs are installed with radio buoy or GPS buoy, the buoys could become non-functional at sea due to broken antenna or the position of the DFADs could be beyond the effective range of radio signals or the buoys could have been destroyed or sunk. The lost DFADs could drift with the oceanic current and finally settle in the ocean's garbage zones.

Since schools of bait fishes that also congregate in the garbage zones could also serve as food for sea turtles, it is not surprising that many sea turtles could be found in the garbage zones. There is therefore very high possibility of sea turtles being entangled with the floating and flexible



Unidentified abandoned DFAD with dead sea turtle and shark caught in a curtain-type DFAD

materials in the garbage zones such as old net sheets, twines, filaments, and the like. Considering that lost and abandoned DFADs could increase the amount of entangling materials in the ocean particularly in the garbage zones, the use of locating techniques such as efficient electronic equipments as well as the design and construction of the DFADs should be improved. Moreover, in designing the DFADs, focus should be made on the concept of durability in rough sea conditions and with efficient buoyancy.

Control and Limitation on the Use of DFADs

The use of DFADs in tuna purse seine operations is very widespread in the vast oceans and high sea fishing grounds of the world. Considering the present crisis in tuna fisheries, *i.e.* high fuel cost and low price of tuna, the ultimate goal of the purse seine operators would be to catch as much as possible a full vessel load of tunas within a short period of time. Thus, the use of DFADs has been considered a very important technique in order for them to survive in the midst of the rough tuna purse seine industry. Even the very skillful and extremely talented European Union (EU) purse seiners adopt the DFADs technique as a primary fishing strategy in surrounding the free swimming tunas (Itano *et al*., 2004). Undoubtedly, any attempt to prohibit or control on the use of DFADs during tuna purse seine operations in the high seas would never succeed.

Nonetheless, the increasing numbers of DFADs used could also lead to increased number of lost or abandoned DFADs in the vast oceans. Consequently, indirect mortality of sea turtles could also possibly increase. It is therefore critical that lost or abandoned DFADs should be minimized or avoided by utilizing modern techniques such as high efficiency radio/GPS buoys and much durable construction materials for the parts of the DFADs. Moreover, the use of biodegradable materials such as coconut or palm leaves

could be re-introduced for the construction of DFADs. Research on the design of non-net materials for the DFADs should therefore be carried out.

Furthermore, the information on the number of deployed and lost DFADs by tuna purse seiners should be collected by coastal states and regional fisheries management organizations (RFMOs). The number of deployed DFADs in all fishing grounds of the world could be used to roughly estimate and access the rate of sea turtle mortalities in the oceans. Campaigns for retrieving abandoned or lost DFADs in the sea particularly in the garbage zones should also be promoted.

Full of confidence, many fishing technologists including SEAFDEC researchers agree that mitigating the mortality of sea turtles by the DFADs, had considerably progressed from the viewpoint of enhanced fishing technology as well as from the fisheries management aspect. However, another concern being put forward by SEAFDEC based on observations during its purse seine fishing trials, is the catching of juvenile tunas by the DFADs. SEAFDEC therefore is encouraging the coastal states and RFMOs to develop technical strategies that could eliminate the catching of juvenile tunas by the DFADs that are being used by large-scale tuna purse seiners as well as to establish the appropriate policies to this effect. Continued adoption of one of the accepted techniques for filtering adult skipjacks which is associated with the presence of juvenile tunas around the DFADs, could lead to an acute diminishing tuna population in the future.

Acknowledgement

The authors would like to express their sincere appreciation to the former SEAFDEC Secretary-General and Chief of SEAFDEC/TD, Mr. Panu Tevarutmaneegul, the Ship Division Head of SEAFDEC/TD and concurrently fishing master of the M.V. SEAFDEC, Captain Sutee Rajruchithong, and the former fishing master of R/V Nippon Maru, Mr. Takehiko Akiyama, for their kind supervision and support during the conduct of the tuna purse seine fishing trials, and also during the preparation of the study report. Special gratitude also goes to the crew of the M.V. SEAFDEC for their full cooperation in the data collection during the shipboard purse seining, more particularly to Mr. Sukchai Arnupapboon and Mr. Weerasak Yingyuad for assisting in the data collection onboard the M.V. SEAFDEC, and to Mr. Narong Ruangsivakul and Mr. Pratakphol Prajakjitt for the illustration of the DFAD construction and design.

References/Further Readings

Anderson J. and P.D. Gates. 1996. Fish Aggregating Device (FAD) Manual, Volume I Planning FAD Programmes South Pacific Commission (SPC). Noumea, New Caledonia

Ben-yami, M.1996 Tuna fishing-a review: Part 4 Purse seining, INFOFISH International volume 3(96): 51-54

Ben-yami, M.1997 Tuna purse seine recent developments, INFOFISH International volume 2(97): 57-62

Boy R.L. Boy and B, R. 1984. Smith Design improvement to Fish Aggregation Device (FAD) Mooring Systems in General Use in Pacific Island Countries. South Pacific Commission (SPC). Noumea, New Caledonia

Chanrachkij I., W. Laongmanee and M. Ishii. 2007. Observation Report on Tuna Fishing Operation in Indian Ocean Onboard R/V Nippon Maru (TD/RES/104). SEAFDEC/TD, Samutprakarn, Thailand

David I., S. Fukofuka and D. Brogan. 2004. The Development, Design and Recent Status of Anchored and Drifting FADS in the WCPO (STCB 17 working paper No. INF-FTWG-3). Marshall Island

David I. 2007. An Examination of FAD-Related Gear and Fishing Strategies Useful for Data Collection and FAD-Based Management (WCPFC-SC3-FT SWG/WP-3). Western and Central Pacific Fisheries Commission, Honolulu, United States of America

Delgado de Molina, A., J. Ariz, J.C. Santana and S. Déniz. 2006. Study of Alternative Models of Artificial Floating Objects for Tuna Fishery (Experimental Purse-seine Campaign in the Indian Ocean) IOTC–2006-WPBy-05

IOTC. 2005. Report of the First Session of the IOTC Working Party on By-catch (IOTC-2005-WPBy-R[EN]). Phuket, Thailand

Itano D., Fukofuka, S. and D. Brogan. 2004. The development, design and current status of anchored and drifting FADs in the WCPO. 17th Meeting of the Standing Committee on Tuna and Billfish. 9-18 August 2004. Majuro, Marshall Islands. FTW6-INF-FTWG-3, 26 pp.

Munprasit A. and I. Chanrachkij. 1993. Observation Report on Tuna Fishing Operation around Seychelles Waters Onboard R/V Nippon Maru 8 November 1992 to 7 January 1993 (TD/RES/32). SEAFDEC/TD, Samutprakarn, Thailand

About the Authors

Isara Chanrachkij is a Fishing Technologist working under the Capture Fisheries Technology Division, SEAFDEC Training Department, Samut Prakan 10290, Thailand

Somboon Siriraksophon, Ph.D. is the Policy and Program Coordinator of SEAFDEC based at the SEAFDEC Secretariat, Bangkok 10903, Thailand

Anurak Loog-on is Second Officer of the M.V.SEAFDEC, Ship Division, SEAFDEC Training Department, Samut Prakan 10290, Thailand

Strategies for Boosting Aquaculture Development in Southeast Asia

Siri Ekmaharaj

While the global population is increasing, many people have become more concerned about their health and are looking for nutritional products. Seafood is the preferred choice of many people around the world in view of its nutritional values. In 2006, the world's food fish production was around 160 million mt of which 83 million mt was from marine capture fisheries, 67 million mt from aquaculture while 10 million mt was from inland capture fisheries. By 2020, it has been predicted that the world's demand for food fish would need an additional 40-60 million mt (de Silva, 2008).

In 2006, the Southeast Asian countries shared about 15% (24.0 million mt) of the world's total fish production (capture and culture combined). With a total aquaculture production of 8.3 million mt in 2006, which has dramatically advanced during the last five years, Southeast Asia accounted for more than 12% of the world's total production from aquaculture (**Table 1**).

The top five aquaculture producing Southeast Asian countries in 2006 were Indonesia (26.5%), Philippines (25.2%), Vietnam (20.3%), Thailand (16.7%), and Myanmar (6.9%) with the remaining 4.4% shared by Cambodia, Malaysia, Lao PDR, and Singapore. The major economically important species being cultured in the region are shrimps and prawns, catfish, marine fishes, carps and barbs, marine mollusks, milkfish, and seaweeds. Due to their economic significance, crustaceans have been the main cultured species in the region, with a very rapid growth demonstrated during the recent years. In terms of value, production from

Table 1. Contribution from Southeast Asian countries to the world's total fish production (2002-2006) in million metric tons (mt)

	2002	2003	2004	2005	2006
Southeast Asian Production	18.682	19.850	21.238	22.674	23.948
Inland Fisheries	1.514	1.481	1.559	1.639	1.890
Marine Fisheries	12.552	13.119	13.294	13.426	13.762
Aquaculture	4.616	5.250	6.385	7.609	8.296
World's Total Production	146.485	146.981	155.822	157.803	159.897
Inland Fisheries	8.718	8.958	8.922	8.716	10.069
Marine Fisheries	85.798	82.821	87.033	85.788	83.081
Aquaculture	51.969	55.202	59.867	63.299	66.747

Source: *FAO FishStat Plus 2008*

the culture of highly-priced crustaceans had an increased share of 45% of the region's total fish production followed by freshwater fishes at 41%.

Aquaculture Production Profile and Opportunities for Development in Southeast Asia

A review of the leading aquaculture producing countries in Southeast Asia showed that there are opportunities and potentials for sustainable development of the aquaculture industry. Specifically, Thailand has been the world leader in shrimp aquaculture since 1994 accounting for around 20-25% of the shrimps in the world market (Ekmaharaj, 2006). The country's total area available for aquaculture is around 70,000 ha with total annual production of about 1.4 million mt out of which shrimp production is nearly 40% (about 500,000 mt annually).

Penaeid shrimps and freshwater prawns

The two major species of marine penaeid shrimps which accounted for over 60% of the region's total crustacean production in 2006 are the white-leg shrimp, *Penaeus vannamei* and the giant tiger shrimp, *P. monodon* (Lymer *et al.*, 2008) with production of about 0.50, 0.35 and 0.34 thousand mt coming from Thailand, Vietnam and Indonesia, respectively. However, these countries have also experienced fluctuations in their annual production primarily due to the impact of viral diseases.

In Thailand, reduction of the farm gate selling price for shrimps pushed the country's area for aquaculture to decrease. As a result, there have been cases where the use of ponds has been diversified to oil palm plantation, rice culture or culture of other fish species such as sea bass or freshwater prawns. Considering the experiences that the Thai fish farmers have over the years in terms of good farm practices, their products are however, more diversified to include frozen products and a wide range of value-added products that boost better marketing chances not only in domestic markets but also in the export market arena.

Vietnam has around 580,464 ha of aquaculture farm areas with a total annual production from aquaculture of about 1,660,000 mt of which shrimp production in 2006 was about 349,000 mt (SEAFDEC Fishery Statistical Bulletin, 2009). However, there is diversity in the species being cultured in the country, *i.e.* temperate species such as *Peneaus indicus* in the northern part, *P. vannamei* in the central part, and *P. monodon* in the southern part. The country's shrimp culture system makes use of small ponds operated on a per family basis making it difficult to adapt good farming practices such as having seawater storage and effluent treatment pond for each small units. Although disease outbreaks have become a related problem, the farmers have signified interests in learning new technologies to mitigate such problem.

In Indonesia, there are around 127,681 ha of aquaculture farm areas giving a total aquaculture production of about 2,377,500 mt/year of which shrimp production is about 340,000 mt (SEAFDEC Fishery Statistical Bulletin, 2009). Aquaculture is mostly operated using traditional or semi-intensive practices, although intensive systems could be promoted if the fish farmers are provided with appropriate training in advanced aquaculture technologies. As a matter of fact, there is a great potential that the country's overall yield (kg/ha) could increase, and if realized could make Indonesia the leading Southeast Asian country in terms of cultured shrimps export in the next 5-10 years.

Freshwater prawn *Macrobranchium rosenbergii* also forms part of the shrimp and prawn products cultured in and exported from the region. Thailand, Indonesia, Malaysia and Myanmar are the top producers in Southeast Asia with annual production of about 29.50, 1.20, and 0.20 thousand mt, respectively (Lymer *et al*., 2008). Within the Southeast Asian region, the freshwater prawn has also good potentials in domestic markets.

Marine fishes

Marine fish culture in Southeast Asia is dominated by sea bass (*Lates calcarifer*), grouper and snapper. Sea bass is the major cultured species with the highest production followed by grouper and snapper, ranking second and third. At least 16 species of groupers are being cultured in Indonesia, Malaysia, Philippines, Thailand, and Vietnam (Lymer *et al*., 2008). Thailand has the highest production from culture of marine fishes at 12,202 thousand mt in 2002 increasing to 31,016 mt in 2005 (SEAFDEC Fishery Statistical Bulletin, 2009). However, Thailand's production dropped to 18,346 mt in 2006. The same pattern was also observed in the production from marine fish culture of Indonesia and Malaysia during the same period (**Table 2**).

Marine mollusks

Marine mollusks, which are mostly cultured traditionally in coastal waters, comprise the green mussel (*Perna viridis*), oysters and blood cockle. Production of mollusks also fluctuated from year to year (**Table 3**). Thailand accounted for the highest production of 400,400 mt in 2004 but such production seemed to be decreasing by about 10% annually (SEAFDEC Fishery Statistical Bulletin, 2009).

Table 2. Production from marine fish culture in 2002-2006 (mt)

Country	2002	2003	2004	2005	2006
Thailand	12,202	14,568	16,945	31,016	18,346
Indonesia	11,518	14,145	4,751	9,428	5,315
Malaysia	5,214	6,188	8,511	8,760	4,336
Singapore	247	304	349	461	450
Philippines	121	449	172	199	242

Source: *SEAFDEC Fishery Statistical Bulletin for the South China Sea Area 2006 (2009)*

Table 3. Production of cultured marine mollusks in 2002-2006 (mt)

Country	2002	2003	2004	2005	2006
Thailand	382,918	357,937	400,400	346,636	314,116
Vietnam	-	-	155,235	143,800	146,200
Malaysia	84,913	79,025	72,731	67,425	53,496
Philippines	24,216	28,000	30,953	36,654	36,566
Indonesia	7	2,869	-	16,348	19,632
Singapore	2,903	2,362	2,396	2,958	5,955
Cambodia	414	524	590	400	500
Myanmar	-	-	-	778	-

Source: *SEAFDEC Fishery Statistical Bulletin for the South China Sea Area 2006 (2009)*

Table 4. Production of catfish in 2002-2006 (mt)

Country	2002	2003	2004	2005	2006
Thailand	86,482	101,618	159,337	140,650	147,287
Indonesia	49,457	71,518	21,836	57,798	60,158
Malaysia	12,656	15,924	19,188	19,186	19,448
Philippines	2,634	2,163	1,390	2,355	2,376
Brunei Darussalam	...	...	27	27	30

Source: *SEAFDEC Fishery Statistical Bulletin for the South China Sea Area 2006 (2009)*

Milkfish

Popularly cultured in the Philippines and Indonesia, milkfish (*Chanos chanos*) can be farmed in freshwater, brackishwater and marine environments. Philippines is the number one producer of milkfish in Southeast Asia with total production of around 315,074 mt in 2006, followed by Indonesia at 212,922 mt. Although traditionally produced in brackishwater ponds, there is now an increasing trend towards mariculture of milkfish, indicating the use of more intensive marine cage culture systems (Lymer *et al.*, 2008).

Tilapia

Although tilapia (*Oreochromis niloticus*) is an exotic species in the Southeast Asian region, it has become a very important species cultured in many Southeast Asian countries, namely: Indonesia, Philippines, Thailand, Malaysia, Lao PDR, and Myanmar. The annual production in 2006 of the region's top six producers was 0.98, 0.19, 0.16, 0.11, 0.29, 0.20, and 0.02 thousand mt, respectively (Lymer *et al.*, 2008). Tilapia can be produced both traditionally and intensively and can be marketed locally and exported to other countries.

Catfish

The catfish species commonly cultured in Southeast Asia is the *Clarias* catfish, which is mainly produced from the hybrid catfish. The four producers of *Clarias* catfish are Thailand, Indonesia, Malaysia, and Philippines with a total production of 229,299 mt in 2006 indicating an increase of about 20.50% since 2002 (**Table 4**). Thailand started to report its catfish production only in 2006 which comprises 37.8% of the total production in the region (SEAFDEC Fishery Statistical Bulletin, 2009).

Another catfish species produced in the region is the *Pangasius* catfish, which is mainly produced in Vietnam. Recently, a very dramatic increase in the production of the *Pangasius* catfish was observed in Vietnam, notably the tra (*Pangasius hypophthalmus*) and basa (*Pangasius bocourti*) (**Table 5**). The country's production area for the *Pangasius* catfish is mainly located in the Mekong River Delta in southern Vietnam. In 2006, Vietnam's production of *Pangasius* catfish reached a record of 450,000 mt (SEAFDEC Fishery Statistical Bulletin, 2009). Following such trend, FAO (Lymer *et al.*, 2008) forecasted that the country's production will surpass 1.0 million mt in 2008. On

the other hand, the country's export data on the Pangasius catfish also indicated a very rapid increase considering that its target market has shifted from the USA to the European Union which now accounts for more than 50% of the country's export in terms of quantity.

Other freshwater species

Carps (Chinese carp) and barbs (Cyprinids)

Carps and barbs are among the most popular freshwater species cultured in some countries in Southeast Asia such as Indonesia, Myanmar, Thailand, and Lao PDR. Myanmar can be considered as a newly emerging aquaculture nation in Asia, especially in terms of production from the culture of barb species such as the *Labeo rohita* (Rohu). Aye *et al.* (2007) cited that the aquaculture production of Myanmar accounted for approximately 22% of the total production from its fisheries sector in 2005-2006. The country's aquaculture production increased significantly in the last decade and the great bulk came mainly from the culture of Rohu. The country's production is particularly important in terms of supplying the source of protein for the populace in rural areas thus, could also be considered as an approach towards poverty alleviation. In 2007, the country's total export from freshwater aquaculture was around 76,303 mt of which production of Rohu was about 59,600 mt (Department of Fisheries of Myanmar, 2008).

Snakehead (Family Channidae)

The total production of snakehead in 2006 in Southeast Asia was 12,115 mt with Thailand, Philippines and Malaysia as the top three producing countries (**Table 6**). Production trends increased from 2002 to 2005 but decreased in 2006 (SEAFDEC Fishery Statistical Bulletin, 2009). Popular only in few countries like Thailand, snakehead does not have a large export market and has minimum potentials in the regional markets of Southeast Asia, where the fish is generally sold live or whole (Lymer *et al.*, 2008).

Aquatic Plants

Aquatic plants cultured in the Southeast Asian region are the biopolymers such as *Eucheuma cottonii*, *Kappaphycus alvarezzi*, *Gracillaria* spp, red seaweeds, and others (Lymer *et al.*, 2008). The Philippines has the highest production of aquatic plants which was about 1,468,906 mt in 2006, followed closely by Indonesia at 1,374,462 mt (**Table 7**).

Table 5. Production of *Pangasius* catfish in 2002-2006 (mt)

Country	2002	2003	2004	2005	2006
Vietnam	135,000	163,000	255,000	376,000	450,000
Indonesia	...	...	23,692	31,488	31,488
Thailand	14,837	23,085	30,626	28,000	22,470
Myanmar	500	800	5,000	5,000	10,000
Cambodia	...	...	3,000	5,000	8,000
Malaysia	3,000	4,282	4,925	5,500	5,524

Source: *SEAFDEC Fishery Statistical Bulletin for the South China Sea Area 2006 (2009)*

Table 6. Production of snakehead in 2002-2006 (mt)

Country	2002	2003	2004	2005	2006
Thailand	5,577	4,205	10,420	12,507	9,438
Philippines	...	1,388	1,272	1,256	1,230
Malaysia	1,329	804	1,163	924	1,057
Singapore	455	535	417	416	303
Indonesia	1,031	970	...	...	87

Source: *SEAFDEC Fishery Statistical Bulletin for the South China Sea Area 2006 (2009)*

Table 7. Production of seaweeds in 2002-2006 (mt)

Country	2002	2003	2004	2005	2006
Philippines	894,857	988,888	1,204,808	1,338,597	1,468,906
Indonesia	223,080	233,156	734,573	866,383	1,374,462
Malaysia	25,625	27,608	30,957	31,426	43,200
Vietnam	...	...	...	30,000	30,000
Cambodia	3,650	7,800	16,840	...	...

Source: *SEAFDEC Fishery Statistical Bulletin for the South China Sea Area 2006 (2009)*

Concerns and Strategies for Sustainable Aquaculture Development

Notwithstanding the rapid growth of the region's aquaculture sector, it is being continuously confronted with many constraints that include, among others: oil price fluctuation, unstable and inconsistent production, impact of climate change, and disease outbreaks. However, strategies can be proposed for boosting the sustainable development of aquaculture in the Southeast Asian region.

Since majority of the people in the rural areas are small-scale farmers, the role of rural aquaculture in providing means of livelihood and ensuring sustainable food supply is becoming very significant and hence should be enhanced. Moreover, the development of mitigation measures on the impact of climate change to aquaculture development would be one of the most significant strategies for the sustainable development of aquaculture. Considering that most of the shrimps, Pangasius catfish, barbs and others produced from the region are mainly for export, eco-labeling the products with traceability would be another strategy so that the region's products could best compete in the world market.

The region's aquaculture sector should also adopt the ecosystem-based approach to aquaculture (EAA) under the FAO initiatives, as guideline for minimizing the environmental and social impacts from aquaculture. Research works on specific pathogen free/resistant broodstocks, new candidate species for aquaculture and alternative protein sources for fish feeds should also be intensified to be able to provide the scientific information necessary in carrying out the important strategies for the sustainable development of aquaculture in the region. Lastly, equally important is human resources development (HRD) in the aquaculture sector which should focus on the capacity building of both human resources in the government sector as well as technicians from the private sector and fish farmers, for advance technologies in order to attain high economic returns from implementing the environmental and social friendly operations along with the requirements stipulated in the EAA approach.

Issues and Constraints in Aquaculture

The very fluctuating oil prices have significant impact on the aquaculture sector as this leads to increasing costs of inputs and other costs such as feeds and transportation, making it very risky for fish farmers to continue their operations. Although aquaculture production appears increasing, but the farm gate price of aquaculture products is decreasing resulting in less profits for the fish farmers. Ventures to increase stocking density in ponds have been tried, but in many cases such attempts led to more frequent water pollution followed by diseases outbreaks. On top of this, the farmers still have to face the impacts of other natural disasters such as floods and storms. Recent demands by importers and consumers to trace the products (traceability) throughout the production chain, has led to the demand for products to be eco-labeled (Ekmaharaj, 2006). This in turn adds more costs on the part of the fish farmers although meeting such requirements could also provide increased foreign market opportunities. Furthermore, in order to mitigate environmental impacts and address social concerns, some improvements on farm routine practices are needed but this could potentially mean more investment costs on the part of the fish farmers.

Strategies for Aquaculture Development

Rural aquaculture for poverty alleviation

The increasing number of fish farmers and aquaculturists particularly in Asia during the past three decades, growing much faster than in the traditional employment in agriculture, is a reflection of strong expansion of aquaculture activities. In 2004 for example, fish farmers accounted for about 25% of the total number of workers in the fisheries sector.

Moreover, in a situation where fishery resources from the wild are over-exploited and affected by multiple water resource use and pollution, the role of freshwater aquaculture in providing means of livelihood and ensuring sustainable food supply in remote rural areas has become very apparent. Thus, it is a key challenge to develop freshwater aquaculture approaches that could open up livelihood opportunities for the rural poor, who could not go easily into aquaculture mainly because of lack of access to capital and resources, vulnerability and aversion to risks (Bueno, 2008). To enable the rural farmers to adopt, operate and sustain relevant aquaculture practices, they would

require access to appropriate skills including knowledge in advance technological and management practices, land and water, financial capital, organizational arrangements, physical facilities, and infrastructures.

In an effort to address such concern, SEAFDEC identified community-based aquaculture as an approach to look into the collective needs of the rural fisheries communities. Under this strategy, SEAFDEC focuses on capacity building where existing regional competence and experiences are compiled and thereafter shared among the countries in the region for adoption based on their respective conditions. This is envisaged to promote appropriate aquaculture systems in the remote rural areas in Southeast Asia where most people appeared have long been ignored due to their isolation from the most basic infrastructures.

Mitigating the impacts of climate change to aquaculture

Climate change has threatened aquaculture activities specifically on the aquatic species being cultured, land/coastal use, energy use as well as on feed supply. On the other hand, aquaculture activities could also influence some changes in the environment. Thus, people involved in aquaculture are sure to face uncertainties in terms of availability of resources and exposure to extreme climate change. SEAFDEC has identified major potential adaptive measures to mitigate the impacts of climate change in aquaculture (**Box 1**).

Box 1. Potential adaptive measures to mitigate the impacts of climate change on aquaculture

Elements of climatic change (CC)	Impacts on aquaculture or related functions	Adaptive measures
Warming	• Raise above optimal range of tolerance of farmed species • Increase in growth: higher production • Increase in eutrophication and upwelling, mortality of farmed stock • Increase virulence of dormant pathogens and occurrence of new diseases • Limitations on fish meal and fish oil supply/price	• Use better feeds, more care in handling, selective breeding and genetic improvements for higher temperature tolerance (and other related conditions) • Increase feed input; adjust harvest and market schedules • Improve planning and siting to conform to CC predictions; establish regular monitoring and emergency procedures • Focus management to reduce stress; set up biosecurity measures; monitor to reduce health risks; improve treatments, management strategies; make genetic improvements for higher resistance • Identify fish meal and fish oil replacement; develop new forms of feed management, make genetic improvement for alternative feeds; shift to non-carnivorous species; culture bivalves and seaweeds wherever possible
Sea level rise and other circulation changes	• Intrusion of salt water • Loss of agricultural land • Reduced catches from coastal fisheries, seedstock disruptions, reduced options for aquaculture feeds; income loss to fishers • Increase of harmful algal blooms (HABs)	• Shift to stenohaline species upstream; introduce marine or euryhaline species in old facilities • Provide alternative livelihoods through aquaculture, building capacity and infrastructure • Make greater use of hatchery seeds; protect nursery habitats; develop/use formulated pellet feeds (higher cost but less environmentally degrading); develop alternative livelihoods for suppliers • Improve monitoring and early warning systems, change water obstruction points where possible
Acidification	• Impact on calcareous shell formation/deposition	• Adapt production and handling techniques; move production zones
Water stress and drought conditions	• Limitations for freshwater obstruction • Change in water-retention period (inland systems reduced, coastal lagoons increased) • Reduced availability and period change of wild seedstocks	• Improve efficacy of water usage; encourage non-consumptive water use in aquaculture, e.g. culture-based fisheries; encourage development of mariculture where possible • Use different/faster growing fish species; increase efficacy of water sharing with primary users, e.g. irrigation of rice paddy; change species in lagoons • Shift to artificially-propagated seeds (extra cost); improve seed quality and production efficiency; close the life cycle of more farmed species
Extreme weather events	• Destruction of facilities; loss of stocks; loss of business; mass scale escape which could potentially impact on biodiversity	• Encourage uptake of individual/cluster insurance; improve siting and design to minimize damage, loss and mass escapes; encourage use of indigenous species to minimize impacts on biodiversity, use non-reproducing stock in farming systems

Considering that aquaculture species are poikilothermic (body temperature changes with the surrounding water), changes in habitat temperatures affect their growth rate, total production, reproduction pattern, and vulnerability to diseases and toxins. Such changes also affect the aquatic species used for feed production. Improved management and better aquaculture practices would be the best and most immediate forms of adaptation. Integrating aquaculture with other practices, including agro-aquaculture, multi-trophic aquaculture and culture-based fisheries, could also offer the possibility of recycling nutrients and using energy and water much more efficiently. Using new species or strains and new technologies or management practices to fit new opportunities is also another option. Aquaculture could also have a role in bio-fuel production through the use of algal biomass or discards and by-products of fish processing.

As fisheries provide significant feed and seed inputs, the impacts of climate change on them will also in turn, affect aquaculture production. Adaptations include changing to less carnivorous species, genetic improvements, feed source diversification, better formulation, quality control, and management. However, trade-offs with other uses (food, bio-fuel, etc.) need to be clearly understood at regional and local levels.

Aquaculture has a relatively small overall CO_2 carbon foot print. Aquaculture of freshwater herbivorous or omnivorous species would require at most small amounts of fertilizer and in some cases, low-energy supplementary feeds. On the other hand, some species and systems such as shrimps and marine carnivores have high feed energy or system energy demands, and consequently higher footprints. Lastly, in the events of extreme weather changes, escapes of farmed stock could occur which could contribute to reduction in genetic diversity of the wild stock, affecting biodiversity more widely.

Mitigating environmental impacts and promoting social welfare

Aquaculture in the Southeast Asian region is mostly small-scale. Hence, some products have often been rejected by importing countries as these are considered below the minimum quality level. Since aquaculture has always been blamed for the deteriorating environment, a series of product quality standards have been required by many importing countries such as the USA and by the European Union (EU). The Southeast Asian countries aiming to export considerable quantity of products for more foreign exchange earnings, are now adopting measures to mitigate the various environmental impacts. Such mitigation strategies include the development of certification in aquaculture by promoting eco-labeling, aquaculture zoning, information management and traceability (Lymer *et al.*, 2008).

While some countries have developed policies for aquaculture expansion, more often than not these resulted in environmental degradation and occurrence of diseases outbreaks. Therefore, attempts are being made to separate the aquaculture areas into zones, where the site of each species such as marine shrimps are zoned to prevent the impact of saline water and other effluents that will have impact to the agriculture fields and the coastal ecosystem. The EAA being advanced by FAO (Soto and Hishamunda, 2008) is guided by three key principles, namely: (i) aquaculture should be developed in the context of ecosystem functions and services with no degradation of the ecosystem beyond its resilience capacity; (ii) aquaculture should improve human well-being and equity for all relevant stakeholders; and (iii) aquaculture should be developed in the context of (and integrated to) other relevant sectors. Correspondingly, the three scales/ levels of EAA applications have been identified as the farm; the water body and its watershed/aquaculture zone; and the global market size scale. Thus, the concept of EAA has been considered an approach that could mitigate the impacts of aquaculture to the environment.

Furthermore, along with the requirements for product quality and residue management, importing countries now require products to be traceable. Therefore, a product traceability system from farm to finished products is now being developed by the countries in the region, although the development is still at a considerably slow pace. Traceability systems are highly dependent on effective information systems based in the geographic locations of the producers, processors and markets; and efficient documentation processes to ensure that the products are clearly identified from point of production to point of sale.

Research on new aquaculture technologies

Pollution and new disease outbreak have constrained the sustainability of aquaculture often leading to great losses on the part of the fish farmers. Research on aquaculture system management and disease prevention are therefore needed. Some countries have policies to increase aquaculture production by increasing stocking density and expanding aquaculture areas. Increasing stocks would require the use of more feeds leading to water pollution which is usually followed by diseases outbreaks. Research on aquaculture system management should also aim to decrease feed conversion ratio (FCR) and reduce the use of feeds through better feed management (Platon *et al.*, 2007). The use of specific pathogen free and resistant (SPF/SPR) fry/ fingerlings could be another option to reduce the risk in farming practices. For example, the white-leg shrimp (*P. vannamei*) can now be domesticated and spawned to produce SPF/SPR fry/fingerlings. In fact, it is for this reason that the culture of white-leg shrimp has also expanded very rapidly in the Southeast Asia region.

Food fish is more popular with increasing high demand, and by 2020 world demands would require an extra 40-60 million mt of food fish. Research to propagate potential wild species could also deliver such demand in the future. The more potential species being laid out for aquaculture would give more chances for people to get into aquaculture, especially the rural people. This could mean better opportunities for providing livelihood and ensuring sustainable supply of food fish in the rural areas.

Alternative materials to be used in the production of aquaculture feeds should be examined. Jackson (2007) reported that 5 to 7 million mt of fishmeal had been produced each year some of which are used as aquaculture feed. FAO (Lymer *et al.*, 2008) has set the general principles of fish as feeds in order to avoid the high demand of transforming fish into feeds. Research on alternative materials as substitute to fishmeal in feeds should be undertaken to decrease the use of fish food which in turn could also reduce fishing by-catch. The result can be beneficial both for fishery conservation and fish farm operations because having alternative ingredients as protein sources in feed formulations could be cheaper than using fishmeal.

Human Resource Development

Human resource development is a strategy that enables all stakeholders to develop and improve their skills, knowledge, and abilities. It could include training, extension, increasing awareness on relevant information, and focuses on the over-all development in order that individual fishers can accomplish the goals of sustainability from the points of view of social and economic aspects of fisheries. In aquaculture for example, human resource development is important so that the stakeholders would become aware and

would be able to adopt the various fisheries instruments, commitments and requirements, *e.g.* the Code of Conduct for Responsible Fisheries, EAA as well as the recently evolving international market-driven requirements, *e.g.*, eco-labeling and traceability. One of the major aspects of sustainability is responsible fisheries management practices. To be able to implement such practices would require improved skills and human capacity on the part of all the stakeholders. Considering also that fact that the success in fisheries management could be attained through participatory approach in co-management, human resource development would play an important role as new levels of capacity are required to enable the fishing communities and resource users to participate in the co-management aspect.

Conclusions

The sustainable development of aquaculture has been constrained with various factors and the demand for eco-labeling aquatic products and traceability documentation requirements of importing countries has made the concerns more complicated. Strategies should therefore be developed for aquaculture in Southeast Asia in order to sustain the region's export quantity and quality as well as enhance the supply quality and enough quantity of fish products for the region's populace. The advancement of rural aquaculture in the region for poverty alleviation could reduce the gap between the region's increasing number of fishers and the food supply. Mitigation measures should also be implemented to address the impacts of climate change on aquaculture as well as the possible environmental and social impacts of aquaculture. Research on new aquaculture technologies, creation of new products and value-adding for export should also be explored. Finally, human resource development should be promoted as the stakeholders need to improve their skills on the various aspects of the aquaculture operations in order to be able to adapt and adopt the various fishery instruments, commitments and requirements, and above all to be able to take part in the co-management.

Acknowledgement

The author is thankful to Dr. Magnus Torell, SEAFDEC Advisor; Ms. Pouchamarn Wongsanga, Information Program Coordinator; and Ms. Saivason Klinsukhon for their support especially in gathering the necessary information for the preparation of this paper.

References

Aye K., K. K. Lay, H. Win and S. de Silva. 2007. A New Freshwater Aquaculture Practice that has successfully targeted a wide export market with major positive societal impacts: Myanmar Aquaculture Asia. Vol. XII (4): 22-26

Bueno, P. B. 2008. Strengthening Sustainable Development of Aquaculture in Southeast Asia: Interventions and Strategies to Enhance the Multiple Roles of Aquaculture in Rural Development. *In:* Fish for the People Vol. 6 No. 3 (2008). Southeast Asian Fisheries Development Center, Bangkok, Thailand; 11-15

de Silva, Sena. 2008. Climate Change and Aquaculture. Regional Consultation on Emerging Regional Fishery Policy, 15-16 July 2008, Bangkok, Thailand

Department of Fisheries. 2008. Statistics of Exported Fish and Fishery Products (2006-2007), Department of Fisheries, Ministry of Livestock and Fisheries, Myanmar: 49 pp.

Ekmaharaj, S. 2006. Aquaculture of Marine Shrimp in Southeast Asia and China: Major Constraints for Export. In: Fish for the People Vol. 4 No. 1 (2006). Southeast Asian Fisheries Development Center, Bangkok, Thailand; 38-43

FAO Yearbook. 2005. Fishery Statistics Capture and Aquaculture Production. Food Agriculture Organization of the United Nations Rome Yearbook: 33-34

Jackson, A. 2007. The global production of fishmeal and fish oil. FAO Workshop, Kochin India 16-18 November 2007.

Lymer, D., S. Funge-Smith, J. Clausen and W. Miao. 2008. Status and Potential of Fisheries and Aquaculture in Asia and the Pacific 2008, FAO Regional Office for Asia and the Pacific, Bangkok, (RAP Publication 2008/15); 90 pp

Platon, R.R., W.G.Yap, V.T. Sulit. 2007. Towards Sustainable Aquaculture in the ASEAN Region. *In:* Fish for the People Vol. 5 No. 1 (2007). Southeast Asian Fisheries Development Center, Bangkok, Thailand; 21-32

SEAFDEC Fishery Statistic Bulletin. 2009. Fishery Statistic Bulletin for the South China Sea Area 2006. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 163 pp

Soto, D. and N. Hishamunda. 2008. Building an ecosystem approach to aquaculture. FAO Proceedings 14, Rome, Italy; 219 pp

Website: http//:www.fao.org/fishery/topic/14850/en

Website: http//:www.vietnamoversea.com. Vietnamese Pangasius Tra Basa Catfish

About the Author

Siri Ekmaharaj, Ph.D., was the former Secretary-General of the Southeast Asian Fisheries Development Center (SEAFDEC). After completing his assignment with SEAFDEC on 30 September 2009, Dr. Siri now serves as the National Consultant for the FAO Project on Certification for Small-Scale Aquaculture in Thailand.

Mitigating the Impacts of Long-line Fisheries on Seabirds and Sea Turtles:
SEAFDEC Operating Guidelines

Somboon Siriraksophon

This set of operating guidelines for long-line fisheries aims to encourage long-liners in the Southeast Asian region to consider eco-friendly operations in long-line fishing. The guidelines cover the factors that could help mitigate the impacts of long-line fisheries on sea birds and sea turtles from the development of the fishing gear, concerns on the reduction of incidental catch of sea turtles and seabirds, and safety at sea for long-liners.

Long-line fishery, one of the most conservative methods of harvesting fish could be of two major types, namely: bottom set long-line and pelagic or drift-long-line. In the Southeast Asian region many countries such as the Indonesia, Malaysia, Philippines, Thailand and Vietnam have been practicing long-line fishing in varying methods depending on the fishers' experiences in terms of fishing and fish handling techniques.

In commercial-scale fishing, the use of long-line technology such as long-line for tuna, sharks and billfishes, catching the most quantity of fish in the least amount of time, is already a thing in the past. These days, issues on resources conservation and management have been included in the focus of the commercial-scale fishing industry. Specifically, addressing conservation concerns and adopting sustainable harvesting practices now take the priority over increased harvests. Towards this goal, a number of projects have been implemented by SEAFDEC under the ASEAN-SEAFDEC collaborative mechanism that aimed to promote responsible fishing technology and practices, and sustainable fisheries in the Southeast Asian region. On the other hand, innovative long-liners are now exerting extra efforts to meet this goal by modifying their vessels, fishing methods, and gear to concentrate only on the target species and eliminate harvesting by-catch and incidental catches.

Development of the Long-Line Fishing Gear

Prior to the development of long-line fisheries, pelagic fishes were caught by hand-line, rod and reel, and harpoon. Long-lining combines the quality afforded by "one-at-a-time-handling" fishing methods with the conservation and efficiency of the "hook-and-line" method. A long-line fishing gear consists of a continuous mainline supported by float lines, with regularly spaced leaders that end with the baited hooks. The original gear consisted of a heavy nylon mainline with 1,000 to 3,000 hooks spaced at depths between 50-250 m along a sea stretch of 15 to 40 nautical miles. Fishing effort focused across vast geographic areas where large pelagic fishes such as tuna, billfishes, sharks and other commercially important species aggregate.

Recently, the gear has been enhanced to consist of monofilament mainline with the main objective of reducing drag and visibility. The length of the float lines and leaders has also been increased to maximize the fishing depths, but the number of hooks has been reduced to prevent tangles. Such modifications are aimed to decrease by-catch from the fishing operations.

The long-line fishing gear of today has many conservation benefits. The spacing between each long-line hook and the reduced number of hooks are meant to minimize the capture rate of non-target species. Smaller hooks and monofilament leaders allow sharks to bite the line, but enable some large spawning stock species such as swordfishes to break off. Additionally, the lighter and longer monofilament gear allows greater movement of the captured fish resulting in higher survival rates. Many fishes are harvested alive and fresh so the marketable species can be processed quickly to provide high-quality fishery products.

Reducing Indicental Catches of Seabirds and Sea Turtles

Seabirds

Referring to the seabirds' distribution areas as also foraging, breeding and migrating areas, long-line fishing boats operating south of 30oS are encouraged to follow the guidelines in **Box 1** to reduce incidental catch of seabirds.

Box 1. Guidelines to reduce incidental catch of seabirds from long-line fishing

(1) bird scaring line (tori-pole/streamer) or tagging along such impediments as buoys or wooden board on the sea surface where the baits are sunk in order to avoid seabirds from taking the baits from the hooks.

(2) Every effort should be made to release the birds caught alive on the vessels and, if possible, remove hooks so that birds would not be harmed.

(3) Dumping of offal is prohibited while the long-lines are being set while dumping of offal during the hauling should also be avoided. If necessary, discharge of such offal materials should take place only on the opposite side of the vessel from where the long-lines are hauled.

(4) One or more of the following measures should also be applied, taking into consideration the situation the gathering of the seabirds and the sea conditions:

- (a) Line-setting should be done between nautical dusk on one day and before nautical dawn on the following day;
- (b) In installing baits, use weighted branch line or cone which sink as fast as possible after line setting;
- (c) Use automatic bait casting machines, if possible; and
- (d) Only properly thawed baits should be used.

Sea Turtles

Billfish Long-line Fisheries

The swimming layer of sea turtles is from the sea surface to 80 m depth water. Thus, sea turtles also stay in the same layer as some pelagic fishes. Fishing operations such as billfish long-lining should therefore consider the guidelines in **Box 2** to reduce incidental catch of sea turtles.

Tuna Long-line Fisheries

For tuna long-line fisheries, the most important thing to do in order to reduce incidental catch of sea turtles is to deploy the first and last hooks of the basket into water depth of more than 80 m to avoid the sea turtles' swimming layer.

Safety at Sea for Long-Liners

Work at sea has never been without danger, and the fishing industry has a long and growing roll of crew losing their lives at sea in the performance of fishing operations. Fortunately, the loss of lives in most types of fishing is now very much less frequent than it was a few years ago. However, there are no technological advances that can fully eliminate the forces of the sea and other natural dangers which the fishing vessel crew should face. It is also not quite possible to eliminate the human errors or those from the tools used in the fishing activity, and it is also impossible to make the fishing vessels and fishing gear completely accident proof. Fishing has, in many countries, already become a highly developed industry employing complex machinery, and such development necessitates the introduction and expansion of safety measures similar to those that apply to other major industries. The high accident rates that continue to affect the fishing industry despite mandatory safety schemes and approaches, have encouraged safety practitioners to propose that a more holistic approach to safety and health culture in the fishing industry should be engendered. Developing safety and health awareness as well as promoting sensitization of the fishing communities taking into account the cost of neglecting safety and health issues should also be advocated.

Safety Assessment

The skipper and other crew members of a vessel are most familiar with the fishing vessel, the machinery including the deck machinery and the gear used during the fishing operations. They are also most aware of the hazards that can occur and can anticipate when, where and how these are liable to happen. By analyzing the possible hazards, the crew can play a vital role in suggesting preventive actions to reduce or eliminate such risks. This process can be better achieved through the initiatives of the fishing vessel owners by properly introducing the proper fishing procedures with

Box 2. Guidelines to reduce incidental catch of sea turtles from long-line fishing

(1) Circle hook size 18/0 with minimum offset (0-10o) which could significantly reduce the rate of hook ingestion by sea turtles should be used instead of the traditional J hook to reduce sea turtles' interaction in the pelagic long-line fishing.

(2) De-hooker and line cutter device should be available on long-line fishing vessels. De-hooker and line cutter facilitate the quick and efficient release of hooked and entangled sea turtles, thereby increasing their chance of post release survival.

(3) Understanding and ability to quickly comprehend each step of the procedures to handle the hooked sea turtles which hauled aboard would greatly help in minimizing sea turtles mortality.

(4) One or more of the following measures should be applied, taking into account the situation where sea turtles are found in the fishing ground.

- (a) Avoid unintentional catch of sea turtles by reducing the time the hooks are in the water during daytime; and
- (b) Use mackerel as bait instead of squid.

the assistance of competent authorities. The procedures could include safety assessment and shipboard or shore side safety aspects. However, the competent authorities should ensure that assistance is also provided to crewmembers while undertaking safety assessment where literacy levels preclude the preparation of written reports.

Insurance Policies

Insurance can contribute to the improvement of safety on fishing vessels by highlighting on the factors that cause accidents. The insurers can financially analyze their business to reduce the costs and by doing so, identify the type of accidents that are occurring and where they are encountering financial losses. By reducing the premiums paid for fishing vessels that undertake specific safety precautions, the insurers can thereby provide an incentive for improving the safety of the fishing industry.

Therefore, it follows that it is the duty of those who employ crewmembers, to ensure that fishing vessels are adequately covered by insurance policies or other financial securities to protect the crew of such vessels and the interests of the crew, to indemnify third parties against loss or damage and to protect their own interests. In particular, they should ensure for example, that the crew are adequately covered for such risks as illness, personal injury, death, wages and shipwreck unemployment indemnity, loss or damage to the effects of a crewmember as well as needs for medical examination, as the case may be. The competent authorities on their part should therefore facilitate access to insurance by companies and persons as well as associations who employ crewmembers in the fishing industry.

Safety in Fishing Operation and Fish Handling

Certain measures developed by SEAFDEC (**Box 3**) should be considered to ensure safety in fishing operations as well as in fish handling.

Box 3. Measures to ensure safety in fishing operations and fish handling

(1) The skipper should ensure that a sharp look-out on all fishing operations is kept at all times and signals which are positive and clearly understood are used.

(2) Many accidents are caused by the failure of running gear when under tension. Fishing gear should therefore be in good order and all parts of the hauling gear, hoisting gear and related equipment should be checked before use.

(3) Baskets, tubs or reels of lines should be adequately secured so that they do not spill or overturn in bad weather. Lines should be coiled carefully and the hooks safely arranged, so that the lines run freely without snags when being laid out. When baiting the hooks or handling lines, crewmembers should at all times take particular care not to injure their hands, and that the hooks do not snag in their clothes. Loose scarves or loose sleeves should not be worn. Crewmembers not directly involved in setting or hauling the lines should keep away from the immediate vicinity of the moving lines, and should handle the glass floats of a line carefully to avoid getting cuts from any broken glass. In setting the lines by hand the crewmember in charge of joining the lines should confirm to the thrower that the next part is connected properly and ready for use. If abnormal constrains occur when the line is being set, which could not be corrected by slowing the vessel's speed, the crew should stand well clear of the line or the line should be cut.

(4) Crew hauling the line hauler should avoid getting their hands caught by the mainline or branch lines. Other crewmembers should stand clear of the hauler at all times. The crewmember operating the hauler should be able to control it quickly and easily. When potentially dangerous fishes are biting or are accidentally hauled on board, they should be killed before they reach the deck, and the hook should not be removed until the fish is dead.

(5) When setting the long-line with a line thrower, the skipper should adjust the speed of the vessel to be consistent with the capability of the line-setting mechanism.

(6) As line storage reels may suddenly reverse when long lines are being set, the crew should be aware of such possibility and avoid having their hands caught, and should take care that they are not injured by floats and branch lines coming back on deck.

(7) In gutting, washing and stowing the catch in ice, the crew should be familiar with the proper handling of different species of fish to avoid hand injuries from the teeth or sharp spines of certain species. Pricks and cuts from fish spines should be bled and treated without delay as some species could cause poisonous wounds which could be painful and troublesome.

About the Author

Somboon Siriraksophon, Ph.D., is the Policy and Program Coordinator of SEAFDEC based at the SEAFDEC Secretariat, Bangkok 10903, Thailand

Assessing the Problems that Impede the Sustainability of Fish Culture in Laguna de Bay, Philippines

Danilo C. Israel

The severity of the various problems confronting the sustainability of fish culture in Laguna de Bay, Philippines was reviewed and analyzed, the results and findings of which are summarized in this article. The study which was jointly conducted by the Southeast Asian Fisheries Development Center/Aquaculture Department (SEAFDEC/AQD) and the Philippine Institute for Development Studies (PIDS) in 2007 aimed to assess the aquaculture development in Laguna de Bay.

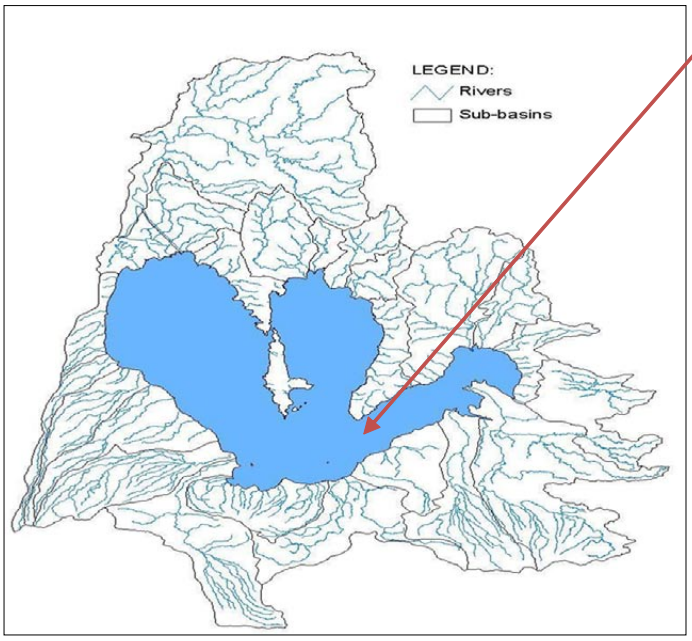


Fig. 1. Laguna de Bay and its watershed
(Source: Laguna Lake Development Authority)

Laguna Lake also known as Laguna de Bay is the largest lake in the Philippines. It is located in the middle part of Luzon bordering the capital region of Metro Manila and the provinces of Rizal and Laguna, and comprising three corporate bays: the west bay, central bay and east bay. The Lake flows and discharges water into Manila Bay through the Pasig River. The watershed of Laguna de Bay also known as the Laguna de Bay Region (**Fig. 1**, **Fig. 2**), has a total area of 292,000 ha and spans across 14 cities and 47 municipalities in the provinces of Rizal, Laguna, Cavite, Batangas, Quezon, and Metro Manila, providing livelihood to an estimated of 13.2 million people as of 2005.

Fish Culture in Laguna de Bay

Aquaculture is an important livelihood in Laguna Lake, where fish farmers use fishpens or fishcages to culture fishes. By definition, fishpen is an artificial and stationary water enclosure for culturing fish and other aquatic animal species. It is made of bamboo poles, wood, screen, and other construction materials intentionally arranged to prevent the escape of fish (**Fig. 3a**). On the other hand, a fishcage is an artificial and stationary or floating water enclosure smaller than a fishpen but made up of similar construction materials (**Fig. 3b**). In Laguna Lake a fishpen is further defined as having a water surface area of more than 1.0 ha while a fishcage has a water surface area of 1.0 ha or less. While a fishcage in the lake generally has a net bottom a fishpen has none. Fishpen and fishcage culture in Laguna de Bay is generally practiced within the aquaculture belt specified by the Laguna de Bay Fishery Zoning and Management

Fig. 2. Laguna de Bay almost blanketed with fish culture structures (*Source: Danilo C. Israel)*

Fig. 3. Fishpens (3a) and fishcages (3b) in Laguna de Bay *(Source: Danilo C. Israel)*

Plan (ZOMAP), where a maximum of 10,000 ha has been allocated for fishpen culture and 5,000 ha for fishcage culture.

The number of fishpen operators and the extent of fishpen culture in Laguna de Bay have increased in recent years. From 2000 to 2006 for example, the number of registered fishpen operators and total area of fishpens in the Lake in particular, have risen at an average annual growth rate of almost 10% and more than 8%, respectively. Furthermore, although the total area of registered fishcages had decreased at an annual average of more than 12%, the number of registered fishcage operators had increased at an average annual growth rate of more than 11%. In 2006, there were 455 registered fishpen operators in Laguna de Bay covering an area of 12,117 ha and 1,599 registered fishcage operators covering an area of 998 ha for a total 2,054 registered fishpen and fishcage operators utilizing a total area of 13,115 ha. Thus in 2006, the maximum limit of 10,000 ha for fishpens was exceeded by 2,117 ha while the area covered by the fishcages was still below the maximum limit of 5,000 ha. The main economic contribution of the aquaculture activities in Laguna de Bay is the fish that is produced, which in 2006 was 48,187 mt generating an income of about Philippine Pesos (PHP) 1.8 billion. The aquaculture industry in Laguna de Bay also employed 5,152 people in 2006 and generated for the government total registration fees of about PHP 84.4 million.

Aside from its economic contributions, aquaculture in Laguna de Bay has significant social implications. Firstly, the fish produced, mostly milkfish, tilapia, and carps are not cash crops but are relatively low-value species and thus, are mainly consumed by the lower economic brackets of the society which comprise the great majority of the country's population. Secondly, the dominant percentage of the cultured fish in the Lake is sold in Metro Manila where a highly significant segment of the urban and relatively politically-sensitive population of the country resides.

Problems Confronting Fish Culture in Laguna de Bay

From a review of relevant literatures, aquaculture activities in Laguna de Bay had always been confronted with various problems that hinder development (Palma *et al.*, 2005; Lasco *et al.*, 2005; Mane 1987; Delmendo, 1982; De La Cruz, 1981; Librero and Nicolas, 1981; Nicolas and Librero, 1977). Such previous research studies on Laguna de Bay identified numerous problems which could be classified into six main groups, namely: technical, production, economic, social, environmental and institutional problems (**Box 1**). Although grouped as such, the problems are not mutually exclusive but are generally and actually interrelated.

Of the various problems confronting the fish farmers in Laguna de Bay, social problems such as poaching, reduction in fishing areas, obstruction of navigational lanes, overcrowding of fishpens and fishcages, and existence of illegal fishpens and fishcages are specific problems which are either fully or partially caused by the aquaculture activity in the Lake. Furthermore, these problems negatively affect not only the aquaculture but also the other sectors in the Lake as well.

In addition, environmental problems such as the occurrence of algal blooms and the deterioration of water quality have been partly attributed as well to the aquaculture activity in the Lake. This could be due to irresponsible practices such as the excessive use of feeds, which leads to eutropication which increases the quantity of phosphate and nitrogen in the water, inducing algal bloom and finally leading to the deterioration of the water quality. Although improper feed management may be occurring to a certain degree, there is also reason to believe that it is not as widely practiced as feared. The results of the survey indicated that about 80% of

Box 1. Problems that impede aquaculture sustainability in Laguna de Bay, Philippines

Technical problems

- **Poorly-sited fishpens and fishcages.** Some fishpens and fishcages in Laguna de Bay, although located in the designated aquaculture belts, are actually poorly sited and not conducive for fish culture.
- **Inappropriate culture practices.** Some fishpen and fishcage culture practices adopted are inappropriate. For instance, the available natural food in the water is not fully utilized by the fish in a monoculture system.

Production problems

- **Occasional low supply of seeds.** Fry and fingerling for stocking are not always available resulting in occasional late stocking, low stocking or non-stocking of some fishpens and fishcages.
- **Poor quality of production inputs.** Production inputs used in fishpen and fishcage culture are of low quality resulting in poor harvest performance and high production costs.
- **High prices of production inputs.** Over the years, the prices of production inputs have been increasing because of the generally inflationary trend in the economy and the rising cost of fuel, among others.

Economic problems

- **Poor quality and low price of fish.** The fish cultured in Laguna de Bay is perceived to be of low quality. As a result, the market price of the fish is relatively low compared with the same species of fish produced by the other areas of the country.
- **Low level of fish processing.** Most of the fish cultured in Laguna de Bay are sold fresh or in frozen form. Fishpen and fishcage operators do not benefit from value addition due to traditional and inadequate technology for fish processing.
- **Lack of foreign markets for produce.** Fish from Laguna de Bay are generally sold only in the domestic market. Fishpen and fishcage operators do not benefit from international trade.
- **Lack of access to cheap capital.** Limited financial capital is a perennial constraint in fishpen and fishcage culture as traditional institutional sources like banks lend only at high interest rates and with stiff collateral requirements.
- **Too many middlemen.** The presence of several consignations, wholesalers, retailers and other fish traders have diluted the income derived by the fishpen and fishcage operators from their operations.

Social problems

- **Poaching.** The stealing of fish from fishpens and fishcages by poachers reduces the profits of operators and increases the chance of social conflict as well as forces operators to spend additional cost on security measures.
- **Reduction in fishing areas.** The construction of fishpens and fishcages, limits the area for fishing by municipal fishermen causing enmity between the fishers and operators of the fishpens and fishcages.
- **Obstruction of navigational lanes.** Some fishpens and fishcages obstruct the navigational lanes used by other sectors leading to conflicts between fishpen and fishcage operators and the other lake water users.
- **Overcrowding of fishpens and fishcages.** Fishpens and fishcages are highly overcrowded in some areas within designated belts causing conflicts among fishpen and fishcage operators.
- **Existence of illegal fishpens and fishcages.** Unregistered and inappropriately constructed fishpens and fishcages exist in Laguna de Bay including those located within and outside the aquaculture belts.
- **Presence of squatters.** The presence of illegal settlers in the coastal areas also caused problems particularly to fishcage operators near these areas as some of these squatters steal the property of operators.
- **Shoreline conversion.** Some coastal areas are already converted for residential, commercial and industrial uses hindering the movement of people and materials involved in fishpen and fishcage operations.

Environmental problems

- **Occurrence of algal bloom.** Algal bloom causes fish mortality or fish kill as stocks die of asphyxiation due to oxygen depletion, while the fish that could survive from such phenomenon could have tainted flesh and mud-like taste.
- **Proliferation of water hyacinth.** Water hyacinths crowding around fishpen and fishcages could also cause fish mortality, destruction of pen and cage structures and obstruction of the navigational lanes.
- **Invasion of alien species.** The proliferation of alien fish species, particularly the janitor fish of late, destroys the nets and competes for natural food and living space with the cultured species.
- **Occurrence of fish diseases.** Cultured fish in Laguna de Bay have also been affected by various diseases that cause fish mortality or fish kill which in turn reduce the viability of aquaculture operations.
- **Deterioration of water quality.** The worsening water quality in Laguna de Bay, which is caused mainly by water pollution results to occurrence of fish diseases, fish mortality and reduced fish quality (**Fig. 4**).
- **Siltation and Sedimentation.** Siltation and sedimentation has made Laguna de Bay shallow and reduced the living space for the fish and other aquatic animals as well as navigational space for man (**Fig. 5**).

Institutional problems

- **Obstructed saltwater inflow.** Fishpen and fishcage operators argue that the backflow of saltwater from Manila Bay into Laguna de Bay through the Pasig River is obstructed. Among others, this reduces the growth and natural food and contributes to the proliferation of water hyacinth.
- **Poor access to training and extension.** Fishpen and fishcage operators have limited access to training and extension, operating mainly based on practical experience. This has contributed to the general practice of traditional and less innovative aquaculture practices in the Lake.
- **Difficult registration process.** The registration process for fishpen and fishcage operations is considered by operators to be difficult, increasing the time spent and financial costs of registration.
- **Overall lack of government support.** Overall technical, financial, economic, market support and law enforcement by the government are considered inadequate by fishpen and fishcage operators. Government agencies are perceived as not doing enough to develop the aquaculture in Laguna de Bay.

Other problems

- **Occurrence of typhoons and floods.** Weather-related events like typhoons and floods destroy fishpens and fishcages causing the escape of cultured fish, destruction of property and economic losses to fishpen and fishcage operators.

Fig. 4. Slums and wastes in Laguna de Bay
(Source: Danilo C. Israel)

Fig. 5. Boys swimming in the Lake's silted shores
(Source: Danilo C. Israel)

fishpen operators and 50% of the fishcage operators adopt the extensive method of culture which depends largely on the natural food in the lake.

Siltation and sedimentation is another environmental problem in Laguna de Bay that may also be partly attributable to aquaculture. The overcrowding of fishpens and fishcages in some areas promotes poor water circulation leading to the accumulation of silt and sediments in such areas. Siltation and sedimentation is furthermore aggravated by the accumulation of decaying bamboos, Anahaw poles and other construction materials that are left rotting in the lake water by abandoned fishpen and fishcage operations. As caveat, however, while fishpens and fishcages may have contributed to algal bloom, reduced water quality and siltation and sedimentation, it may not be a major cause of the environmental problems in Laguna de Bay. For instance, Bacallan (1997) explained that of the water pollution in the lake, 40% came from agricultural sources, 30% was caused by industrial sources, and 30% came from domestic sources. Centeno (1987) further identified industrial effluents, sanitary wastes, and effluents from agri-business, run-off from agriculture and inflows from the Pasig River as among the various sources of water pollution in the Lake.

Severity of the Problems

Through a questionnaire survey, the perceptions of fishfarm operators in Laguna de Bay on the relative severity of the various problems confronting their aquaculture operations were collected and analyzed. Thereafter, the problems were ranked in terms of their relative severity and tested for significant differences. The results showed that the problems which were ranked as most severe were the environmental problems such as the deterioration of water quality, siltation and sedimentation, invasion of alien species, proliferation of water hyacinth, occurrence of algal bloom, and occurrence of fish diseases. Of these environmental problems, in particular, the deterioration of water quality, siltation and sedimentation and invasion of alien species were found significantly different from the other problems in terms of relative severity.

Outside of the environmental problems, there were individual problems which were also ranked highly in terms of their relative severity. Specifically, these problems include the social problem of poaching, institutional problem of limited overall government support, and the economic problem brought about by lack of access to cheap capital.

Results of the analysis further indicated that most of the problems were considered by most aquaculture operators in Laguna de Bay as at least lightly serious. Moreover, many of the problems, particularly those classified as technical, economic, social, institutional, and other problems were considered by most respondents as moderately serious. Furthermore, few respondents considered that the problems have not really impeded their operations while a substantial number of respondents had no opinion.

In summary, the analysis therefore showed that environment-related problems in Laguna de Bay are the most severe among the problems perceived by the fishpen and fishcage operators as seriously confronting their aquaculture operations. In addition to the environmental problems, other individual issues were also considered most severe particularly poaching, lack of overall government support and lack of access to cheap capital. It is important to remember that some of the problems considered as very serious are also those that are partly or fully caused by the aquaculture operations in the Lake.

Conclusion and Recommendations

The results showed that while aquaculture in Laguna de Bay is economically and socially important, it is facing numerous problems foremost of which are the environmental problems. These problems, therefore, have to be prioritized and addressed if aquaculture is to continue in the Lake in the future. Along this line, the important courses of action outlined in **Box 2**, most of which have already been put forward by some sectors involved in fishpen and fishcage culture in Laguna de Bay, are strongly recommended for a more rational management of aquaculture in the Lake.

Box 2. Recommendations for more rational aquaculture management in Laguna de Bay, Philippines

- Illegal structures in Laguna de Bay should be immediately dismantled. The total area allotted for fishpens of 10,000 ha, in particular, has been exceeded already even counting registered fishpens alone. Among others, dismantling will help improve the environmental conditions in the lake.
- The optimal area for fishpen and fishcage culture in Laguna de Bay should be determined once and for all, as some sectors argue that the present allotment of 15,000 ha is too large. There are also concerns that the allotment is beyond the specified 10% of the suitable water surface area of all lakes and rivers mentioned in the Philippine Fisheries Code of 1998.
- Research agencies should fund and conduct more research on environmental problems in Laguna de Bay. As environmental problems have been considered relatively more severe than any other problems, emphasis should be put on such concerns in order to serve the interests of the numerous stakeholders who depend on an environmentally sustainable lake for their livelihoods and needs.
- A clean-up of the waters of Laguna de Bay of decaying bamboos, Anahaw poles and other materials should be done. This activity may be conducted by the aquaculture operators within and around their fishpen and fishcages while the government can undertake clean-up campaign in the open areas.

References

Bacallan, J. J. 1997. The race to protect the Laguna de Bay region. Business and Environment, World Bank, January-February 1997 Issue

Centeno, J. D., Jr. 1987. Pollution sources and control. In: Philippine Council for Agriculture and Resources Research and Development. State of Development of the Laguna de Bay Area. Proceedings of the Seminar-Workshop on State of Development of the Laguna de Bay Area, Los Baños, Laguna, Philippines; 30-33

De La Cruz, C. R. 1981. Fish pen and cage culture development project, Laguna de Bay, Republic of the Philippines. Paper Presented in Field Level Workshops for the Fish Pen/Cage Development in Laguna de Bay, FAO/TCP South China Fisheries Development and Coordinating Programme, October 1981. http://www.fao.org/docrep/field/003/ab755e/ab755e00.htm

Delmendo, M. D. 1982. Fish-pen aquaculture development on Laguna de Bay, Philippines. In: A. G. Coche (ed.). Coastal Aquaculture: Development Perspectives in Africa and Case Studies from Other Regions, Vol. CIFA Technical Paper No. 9, Food and Agriculture Organization, Rome

Lasco, R. D., M. V. O. Espaldon and M. A. Tapia (eds.). 2005. Ecosystems and People. The Philippine Millennium Ecosystem Assessment (MA) Sub-Global Assessment. College of Forestry and Natural Resources, University of the Philippines at Los Banos, College, Laguna, Philippines; 233 p

Librero, A. R. and E. Nicholas. 1981. The economics of fishpen farming in Laguna de Bay, Philippines. SCS/PCC/WP-9, Laguna, Philippines

Mane, A. M. 1987. Fishpen culture in Laguna de Bay. In: Philippine Council for Agriculture and Resources Research and Development. State of development of the Laguna de Bay area. Proceedings of the Seminar-Workshop on State of Development of the Laguna de Bay Area, Los Baños, Laguna, Philippines; 25-29

Nepomuceno, D. 2004. Addressing freshwater conflicts: The LLDA experience in Laguna de Bay. Presented at the Workshop on Natural Resource-Based Conflicts in the Philippines Sponsored by the United States Agency for International Development (USAID) and the Department of Environment and Natural Resources (DENR), May 13-14, 2004, Westin Philippine Plaza, Pasay City, Philippines

Nicholas, E. S. and A. R. Librero. 1977. A socio-economic study of fish pen aquaculture in Laguna Lake, Philippines. Paper presented at the Second Biennial Meeting of the Agricultural Economics Society of Southeast Asia, 3-6 November, 1977, Tigbauan, Iloilo, Philippines; 16 p

Palma, A. L., E. C. Mercene and M. R. Goss. 2005. Fish. In: Lasco, R. D., M. V. O. Espaldon and M. A. Tapia (eds.). Ecosystems and People. The Philippine Millennium Ecosystem Assessment (MA) Sub-Global Assessment. College of Forestry and Natural Resources, University of the Philippines at Los Banos, College, Laguna, Philippines; 117-132

About the Author

Danilo C. Israel, Ph.D. in Resource Economics, is a Senior Research Fellow at the Philippine Institute of Development Studies, Makati City, Philippines

Improving Environmental Management to Enhance Natural Resource-based Livelihood Assets: A case of Cu Lao Cham Archipelago, Vietnam

Nguyen Ngoc Phuoc, Nguyen Giang Thu and Ta Thi Thanh Huong

Cu Lao Cham (CLC) is an archipelago comprising eight islands some 18 km offshore from the ancient town of Hoi An in the eastern part of Quang Nam Province in central Vietnam (**Fig.1**). Coral reefs, sea grass beds, rocky shore, and sandy bottom are the important aquatic life habitats in the archipelago. The coral reefs and sea grass beds are the most productive ecosystems. Recognizing the importance of the area in terms of environmental and socio-economic considerations, the Cu Lao Cham archipelago with total area of 6719 ha including 165 ha of coral reefs and 500 ha of sea grass beds, has been developed into a marine protected area (MPA).

The National Plan on Environment and Sustainable Development (NPESD) and the Biodiversity Action Plan (BAP) of Vietnam promote the establishment and management of MPAs. Starting in 2000, the 15 representative MPA sites proposed by the Ministry of Science, Technology and Environment of Vietnam had been carried out, the corresponding management regulations formulated, and the first comprehensive MPA pilot site was established in Hon Mun. Meanwhile, the project "Support to the Marine Protected Area Network in Vietnam" was started in October 2003 with the assistance of the Danish International Development Assistance (DANIDA). Consisting of two sub-projects to address priority needs at both national and provincial levels, the project at the national level has developed the existing network of MPA sites through capacity development and strengthened policy and legal frameworks. At the provincial level, Cu Lao Cham in Quang Nam Province was developed as the second MPA site under the said project.

A recent assessment of the coastal resources around Cu Lao Cham MPA indicated severe over-exploitation, resulting in the decline in marine resources. Local inhabitants confirm that the once abundant resources have decreased mainly because of over-exploitation as high demand for live fish and the use of unsustainable fishing practices continue to prevail. Such alarming situation called for the urgent need to adopt appropriate resource management systems to protect the natural resources in the CLC MPA. Thus, community-based resource management has been introduced and is now being applied in the management of Cu Lao Cham MPA. Based on the premise that local populations have greater interest in the sustainable use of natural resources, such resource management system has been to some extent successfully implemented in the MPA. Results of the assessment showed that the management system introduced in the MPA enhanced local awareness of resource protection and management, reduced pressures on the ecological systems, and raised awareness and understanding of the local people of the links between natural resource management and improved local livelihood systems.

Enhancing Environmental Management System: A Case Study

The case study was conducted in Cu Lao Cham in 2007. It aimed to assess the progress of the improved management system and evaluate the status of the MPA. As also envisaged, the results could yield valuable lessons for the better management of the other MPAs in Vietnam. Specifically, the study was aimed at assessing the potentials of the local people particularly the women's group, in improving their natural resource-based livelihood assets through improved environmental management. The study also

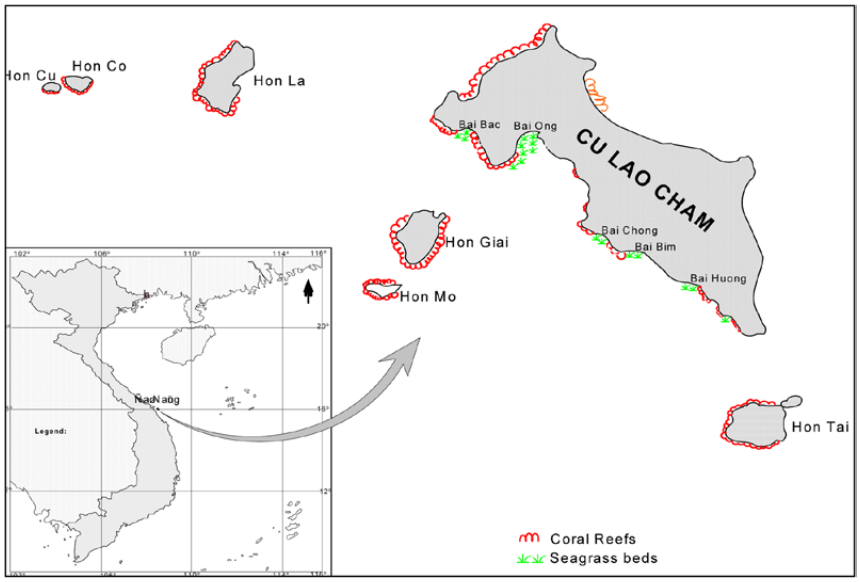


Fig. 1. Cu Lao Cham Archipelago, Qu□ng Nam Province, central Vietnam (Tuan *et al.*, 2006)

intended to evaluate how empowerment of the local people to manage their own resources could reduce environmental mismanagement and corruption that threaten their natural resources.

In order to have a good background on the status of the MPA in the CLC archipelago, a review of the studies conducted earlier in Cu Lao Cham Archipelago was carried out. The information for the review included the reports of two projects, namely: "Support to the marine protected area network in Vietnam" and "Sustainable Livelihoods in and around Marine Protected Areas".

Results of the review suggested the various measures to gather field data such as field visits, meetings with key informants, semi-structured and open-ended interviews, and focus group discussions. A major part of the field visits was the interview of the local people who had participated in the various vocational trainings that were conducted under the aforementioned projects. Identifying the gains and losses of alternative income generation schemes on the CLC was crucial, generating lessons and experiences that could be shared with the other poverty alleviation activities in coastal communities.

Participatory poverty assessment (PPA) and participatory rural assessment (PRA) methods were used to assess the state of the natural resources. For sustainable livelihood assessment, selected households took part in the focus group discussions where open-ended questions were asked and brainstorming for ideas was carried out.

Two livelihood assessment sessions were conducted, one in Bai Lang village and other in Bai Huong village which targeted two groups, namely: the diving households and the coracle-only fishers. The groups were selected based on the results of the most recent livelihood survey conducted by the CLC MPA office. Focus group discussions were designed to identify the local people's needs and obtain their ideas on livelihood options based on the available natural resources. Opinions in terms of inputs and support required, markets, and the constraints to development, were also drawn from the respondent groups. This was meant to encourage the respondents to take active part in the needs assessment sessions and to stimulate the community to think critically about potential alternative income generation opportunities in the CLC archipelago. In order to cross check as well as confirm the results, interviews were conducted with representatives from key government departments with knowledge of the CLC community and local livelihoods, and who have been involved in the country's various alternative income generation processes.

Perceptions of local populace on the natural resources

Hon Bien (area: 1549 ha) is located in the largest island of the archipelago, with two villages: Bai Lang with 2500 inhabitants and Bai Huong with 450 inhabitants. Cu Lao Cham inhabitants are highly dependent on the natural resources for their livelihood. Fishing, hand collecting, diving and trading different types of seafood products are the main sources of income for the CLC inhabitants.

The degree of the level of dependence was established using the socio-economic background of the CLC communities. The results showed that the local inhabitants have an average experience of 20 years in jobs related to fishing. The high level of dependence on the natural resources has been transferred to the young generation; it is common to find more than one generation in the same fishing boat. There are no other activities considered by local inhabitants as alternatives to reduce such high level of dependence.

The CLC inhabitants did not seem to be aware of their high level of dependence on the natural resources. This is in spite of their complaints that there had been significant decrease of about 75% in the abundance of the aquatic products during the past two decades, specifically in 2004 to 2005. The locals also reported that some species have almost disappeared while some existing species are quickly declining in number and decreasing in harvestable size. They also cited that on the average and depending on the species, there has been a decrease of 70-90% compared to the status 20 years ago, 50-70% about 10 years ago and 30-50% compared to the trend in 2004. The local inhabitants admitted that this decrease could be caused by over-fishing or illegal fishing activities. The reports also suggested that sustainable livelihoods in and around Cu Lao Cham archipelago are intimately

associated with the sustainable management of the whole country's marine resources, especially the fishery resources. The study therefore suggested that it is important to make the local inhabitants understand that sustainable growth of the fisheries must be anchored on the protection of coastal and marine habitats.

Assessment of the current situation of resource exploitation and management

Cu Lao Cham is an important fish landing area and its waters as fishing grounds of Quang Nam Province. Different fishing activities including hookah air diving, purse seine and gill net, light fishing, drift nets, long line and trap are commonly used in CLC archipelago, with a variety of marine organisms being harvested (**Table 1**). The most commonly exploited marine resources are fish, cuttlefish, squid, shrimp, lobsters, gastropods and clams, of which groupers, lobsters, sea cucumbers, and gastropods are harvested year around while pelagic resources such as cuttlefish, tunas, mackerels, anchovies are seasonally caught with peak season from December to April.

The Vietnam-Denmark Cooperation project had identified the Cu Lao Cham MPA as an example of how lack of environmental protection had caused a decline in the islands' marine resources and biodiversity. In this connection, the study confirmed that such situation has greatly affected the islands' poorer households that depend heavily on fishing around the islands for subsistence. Enforcement of laws and regulations seemed to be ineffective. The other communities felt powerless to deal with such a situation, which would likely impact on the future generations (LMPA document). For example, dynamite fishing and the use of chemicals to catch live fish are still practiced although these have been banned during the last several years.

While the Cu Lao Cham archipelago is heavily over-exploited by local villagers, "outsiders" mostly coming from nearby mainland villages in Quang Nam Province and Quang Ngai, Da Nang, and Phu Yen Provinces also fish in the CLC fishing grounds. While some fishing activities could be for subsistence, the active market for live fish in nearby restaurants and export markets in mainland Vietnam had induced the over-exploitation status of the CLC resources (LMPA document).

Fishing pressures by large fishing boats and small vessels, using various fishing methods including trawl, fixed semi-permanent nets, light fishing with lift/push nets, purse seine with/without lights, hookah air diving with/without poisons, hook and line, and barrier nets, have tremendously increased. Although trawling is mostly conducted in offshore areas, it still poses danger to the coral reefs and especially the juveniles of demersal species. Hookah air diving with or without poisonous chemicals has been continuously used in the area during the last decade to catch live groupers and lobsters. Recently, post-settled and juveniles of tiger lobsters have been harvested by the local hookah divers to be utilized as seedstocks for the lobster cage culture in the mainland. The under-sized lobsters caught could pose potential serious reduction of the lobster resources in the CLC archipelago. Other marine resources on the coral reefs are also heavily exploited and many commercially species have been declared as rare, endangered or critically endangered levels. In fact, four species of living organisms in Vietnam had already been listed in the IUCN Red List of Threatened Animals (IUCN 1993).

Table 1. Main fishing activities and marine resources collected in Cu Lao Cham

Fishing activity	Fishing season	Main marine organisms caught
Hookah air diving	Year round	Groupers, sweetlips, top shells, triton shells, giant clams, lobsters, ornamental fish and live corals
Net (gill net, purse seine, drift net)	Year round	Sweetlips, snappers, cardinal fish, coral breams, anchovies, rabbit fish, scads, travellies, jacks
Light fishing	December - April	Anchovies and cuttlefish
Long line	December - April	Cuttlefish and fish (tunas, mackerels)
Trap	December - May	Cuttlefish and fish

There is also an urgent need to increase the awareness among external users of MPA's, particularly the tourism and commercial shipping sectors. Physical impacts from commercial shipping plus marine pollution from ship wastes may not be visible but dredging and construction activities of the fishing port in the Cu Lao Cham potentially affected the health of nearby coral reefs. The absence of any port waste reception facilities (garbage and wastes are discharged without pre-treatment), is just among the threats to the marine habitats in the CLC. Moreover, the Cu Lao Cham MPA is also negatively impacted by the discharges of two rivers; Thu Bon River in the south and Han River in the north have brought about increasing erosion of the coastline, sedimentation, and accumulation of waste discharge.

Local livelihood systems

There are a number of different livelihood activities in Cu Lao Cham archipelago, all of which are dependent on the marine resources (**Box 1**). The three main income levels in the CLC archipelago are shown in **Box 2**. Based on the livelihood-income analysis, the three main disadvantages that could contribute to the difficulty in achieving livelihood development in the CLC archipelago had been identified as follows:

- ***Poor skills.*** Producers of fish sauce, mushroom, and processed seafoods could not sustain their production as they are often confronted with technical problems, resulting in the unstable quality of their products. There is therefore a need for further training of the local people on the proper methods and skills in processing as this is considered suitable and feasible for further development in the island as an alternative source of income for the local populace.

Box 1. Livelihood activities in Cu Lao Cham archipelago

Hand collecting: Collection of mollusks from the intertidal zone is usually done on foot or using small boat, also called a coracle, in different sites in the archipelago. Collectors normally do the work alone or in small groups of 2 or 3 persons. The mollusks are collected from rocks using simple tools like hammer and chisel or knife. Improvised oxygen masks are also used if the situation requires swimming in deeper waters for the mollusks. Collection is done at low tide which is usually one day after full moon and in the first few days of new moon, thus collection could be done only about 5-10 days a month and few hours per day. The main season is during summer (March-August or April-July) when the weather is good and the demand for mollusks by tourists is also good. For the other times of the year, the hand collectors have to look for other jobs.

Three layer net fishing: The 3-layer net is used during the winter months (October-February or December-April) when the sea is too rough for other types of fishing such as diving or using the surround lift net. The fishermen go to sea everyday during the fishing period alone or group of up to 3 persons per boat. The 3-layer net is positioned near the bottom of the sea which is about 20 m to 1 km from the shore, with depths that vary from 10 to 60 m. In general, the two outside layers of the net have a mesh size of 44 cm on the diagonal and the inside net layer with mesh size of 12 cm on the diagonal. The fishing time varies since fishers could sometimes stay fishing the whole day from 4 AM to 3 PM or sometimes only a few hours at night from 5 to 9 PM. When the sea is rough (January-February) the net is put far offshore (1 km) during the day, otherwise during March-April, the net is put 100 m from shore and left for 24 hours. Also, when a net is newly made it is put further away from the shore (coral and rocky areas) but as it gets older it is set closer to the shore.

Surround lift net fishing: The surround lift net is used during the summer months (May to November sometimes as early as February) and set all around the CLC archipelago at distances ranging from 100 m to a few km from the shore and at 15-60 m depth. The fishing activity is carried out 5 PM to 6 AM, 15-25 days/month. The surround lift net has a small mesh size on the diagonal which is 1-3 cm, which gets smaller at the bottom, sometimes 12 mm or sometimes even as small as 5 mm on the diagonal. About 100-200 m long and 15-20 m high, the surround lift net is positioned at the surface in a U shape with the mouth of the net about 35 m wide. One or two boats operate the net involving 5-10 persons per boat using neon lights to attract the schools of fish.

Diving: Since there are no professional divers in Bai Huong village with equipment, this activity is carried out only in Bai Lang where there are about 20-30 fisher-divers, diving around the CLC archipelago (Hon La, Hon Kho, Hon Dai, Hon Lao, Hon Tai and Hon Mo) in the coral and sea grass areas about 50 m up to 3 km from Bai Lang. Diving is done all year round except during very bad weather. At 200-300 m from the shore the water is up to 45 m deep, but in winter the divers stay closer to the shore and at shallower depths of 10-15 m. Diving is done 5 days a week or 20 days a month.

Long line hook fishing: This activity is carried out 12 months a year by 40-50 boats in Bai Lang as there are no long line hook fishermen in Bai Huong. The boat is about 10 m long with 11-21 HP engines. About 3-6 fishers are in a boat (approximately 200 long line hook fishers are in Bai Lang). They go fishing east of Hon Lao up to 40-60 km offshore in March-June, for about 15-20 days a month. A trip usually lasts 3 days as it can take 5 hours to reach their fishing ground. From July to February when winds are stronger, the fishers stay close to the island about 200 m from the shore. Only one type of hook is used each time but the smaller hooks are used to catch the bait on the first day, which is usually cuttlefish. The length of the line can be 3-10 km and the distance between the hooks depends on the hook, which can be 2 m, 4.5 m or 45 m so about 70-2000 hooks are used at one time.

Fish purchasing: Fishers from CLC sell high value fish to dealers in Bai Lang and Bai Huong, which include those collected from coral reefs such as cuttlefish, grouper, parrotfish, swimming crab, mackerel, and lobster. If the fish are alive, these are kept in a small cage in the sea but if already dead, the produce is kept in ice containers. Lobsters are usually kept alive in a small container with seawater and provided with compressed air bubbles. The dealers also act as money lenders offering loans to fishers to buy equipment and the fishers could pay them back with fish.

Trading: This is carried out by women everyday at Hoi An market, working from early morning until the fish are sold by about 2 PM. The husbands of some market sellers are fishers in the CLC area, e.g. using the surround lift net and trawl net or some are owners of boats that mainly collect mollusks. In cases when the aquatic products are bought directly from the fishermen at cost, the sellers could make more profit. Some sellers buy directly from the dealers in the CLC while others buy from the collecting boats at the mouth of the estuary or at the Hoi An market.

Box 2. Three main income levels of CLC archipelago inhabitants
1. The low-income people are those working in fishing boats as laborers and the hand collectors. The incomes of these workers are often augmented by doing different jobs to get enough wages to support their families. Fishing with three-layer net is also an important source of income. In Bai Huong, 100% of the people use the 3-layer net and these fishers represent the working class of the CLC archipelago. With only little income, they could not invest in boats and equipment, and live in modest conditions in simple houses often rundown and almost empty with no furniture. The average earnings per person could be around 50,000-100,000 VND per day, working between 10 and 25 days per month. The income level could range from 12,000,000 to 30,000,000 VND/year.
2. The intermediate income level includes the owners of fishing boats and long line hook, the surround lift net fishers as well as the divers. For the divers and surround lift net fishers, 3 layer net fishing represents an important alternative source of income during winter when the weather is bad. These people represent the entrepreneur class of the CLC archipelago, investing money in boats and equipment with the hope to transform initial investments into good profit. They live in good houses, sometimes just built or freshly decorated, with furniture inside. The average earning per person is about 150,000-300,000 VND per day, working between 10 and 30 days per month, thus the income level could range from 30,000,000 to 60,000,000 VND/year.
3. The high-income people are the dealers, who are the people with money, offering loans to the fishers and divers. The dealers represent the trading/investors class. Dealers lend money in exchange for favorable seafood products and prices. They have good houses with furniture and electrical appliances. Considering the high risk taken by the dealers in delivering live animals to customers in Hoi An or Danang, therefore their profit could only be 3-5% out their initial investment. Their income level could range from 60,000,000 to 120,000,000 VND/year.

- ***Inadequate market channel.*** As the CLC archipelago is far from the mainland and with difficult transport system especially during the stormy seasons, prices of production inputs could increase and preservation of fishes could be difficult to undertake. This weakens the competitiveness of products from the archipelago compared with similar products sold in the mainland's local market. For example, the CLC-produced fish sauce could be twice as expensive as the low quality but cheaper fish sauce produced in the mainland.
- ***Lack of an effective system for livelihood support.*** Poor fishing households lack adequate financial resources to take up any new occupation. This is a crucial issue to resolve in any livelihood support mechanism in the MPAs that is developed in cooperation with local governments and other stakeholders. It should therefore be addressed at the planning stage of the assistance program.

Gender issues

In the typical fishery-based economy of Cu Lao Cham MPA, boys and men have greater opportunities for education and employment in the fishing industry than girls and women. The schools and health clinics in the CLC archipelago have limited facilities and staff. There are only six teachers and one doctor for almost 4000 inhabitants, as it has always been difficult to attract well-qualified teachers to the remote islands (LMPA document).

When families have to bear the additional costs of sending their children to schools by boat or sending sick relatives to the mainland for treatment, inevitably girls and women are less favored than boys and men. It is particularly difficult for young women to receive further education and good employment opportunities especially if it involves going to the mainland. Consequently, many young women remain at home to help support the family through housework, net mending, fish processing, feeding livestock, etc. Old women are the most vulnerable group and have to depend on subsistence activities such as gathering and selling firewood.

The role of MPA establishment in poverty alleviation and gender equality

The principal objective of establishing MPAs is to instill in the minds of fishers living in and around MPAs the need to redirect their activities towards more sustainable fishing practices. The Cu Lao Cham MPA project has limited short-term impact on poverty alleviation in terms of improvements in local living conditions through habitat protection, diversification of resource utilization and community development support. In the long-term however,

an improved marine environment could be achieved. The establishment of the CLC MPA was envisaged mainly for the recuperation of the biological losses over time in order to improve fishery production. As planned, alternative income generation was made part of the establishment of the CLC MPA, mainly feeding into the poverty reduction objectives of the project.

On the gender issues, the Quang Nam MPA project works closely with the Women Union to compile and share experiences with other women's groups. The women in Cu Lao Cham are also engaged in fishing activities, although most of them operate in the shallow nearshore waters. A few women have their own fishing equipment. In collaboration with the Fishermen Union, Women Union, and Youth Union, the MPA project helps increase the awareness and understanding of the women's group in marine resource protection and the role of the MPA in enhancing sustainable harvesting as alternative to destructive fishing practices. The MPA project also enhances the active participation of women and young people in the promotion of the MPA, especially through environmental education in schools, and environment and health training for local women. Finally, it raises awareness regarding the planning, implementation and sustainable management of the targeted marine areas as well as the potential harmful impacts to the marine resources.

Opportunities for ecological tourism

The CLC archipelago has great potentials for ecotourism development. However, with various advantages come the corresponding concerns (**Box 3**). The increasing number of tourists visiting Cu Lao Cham has already put pressure on the resources while the number of local restaurants in Bai Lang selling marine aquatic delicacies has increased. Meanwhile, the increased demand for limpets has led to the increasing number of hand collectors. Aside from limpets, the other species being heavily targeted are the turban shells. In some places around the Cu Lao Cham islands the abundance of limpets and turban shells has drastically gone down. Tourism could provide an alternative source of income especially for those who are dependent in fishing. But it could also have adverse impacts on the aquatic resources.

Community-based management in Cu Lao Cham MPA

The local communities in Cu Lao Cham archipelago have been involved in the management of the MPA through an integrated management system. The management plan developed for Cu Lao Cham MPA was grounded on a community-based management approach. Capacity development for the Cu Lao Cham management board has also been initiated in the areas of operational planning,

Box 3. Advantages and concerns on Cu Lao Cham as ecological tour destination

- The CLC archipelago has beautiful landscape and rich biodiversity in its terrestrial and marine ecosystems. The forest on Hon Lao has a diverse flora and fauna with birds, butterflies, reptiles and other terrestrial life. CLC also has beautiful beaches, and the coral reefs are in good condition. In addition to the diverse and abundant natural resources, CLC also has charming and distinguished historical, cultural and religious life which can be gleaned from various temples, pagodas and archaeological relics. Rather isolated from the mainland, the CLC archipelago has had least adverse effects from the fast growing economic development and urbanization, hence it is potentially a wonderful get-a-way destination for domestic and international travelers.
- The coral reefs and the aquatic biodiversity around the CLC islands also make the archipelago a potential place for diver-tourists. In fact, two commercial dive centers have been established, and that it has been estimated that a kilometer of coral reef could be worth up to 1.2 million USD in terms of the corresponding services and provisions. However, currently the two commercial dive operations do not have any contact nor any form of commitment with the communities on the island. There should be a regulation requiring every diver-tourist to pay certain fees to the local communities for the protection of the coral reefs. More particularly, regulation must be imposed for the diver-tourists to avoid putting too much pressure on the reefs as otherwise this can be deleterious to the habitats being protected under the MPA system.
- A visiting Danish student during his field trips in 2005 and 2006 stressed that the CLC MPA has the potentials to become an attractive destination for many forms of eco-tourism such as student field courses on environmental education, marine and terrestrial biology, archaeology, cultural studies, tourism development, and other scientific activities. However, even if the main island (Hon Lao) can be reached within 20 minutes by fast boat from Hoi An, but the frequency of these trips is weather dependent. A regular high speed boat operated from Da Nang which could accommodate 30 persons/trip was stopped in 2006 because there were few visitors. There are only few boats operating everyday including a regular ferry service carrying mostly local residents, supplies, freight and mails as well as tour groups and individual travelers on day-excursions including dive trips. The tours are operated by entrepreneurs from the mainland but not by the islanders.
- Poor infrastructure is another major obstacle for the island tourism development. Electricity is cut off during the day time and could only serve the island from 6 to 10 PM. A garbage collection system is temporarily operating in Bai Huong but there is none for the rest of the main residential island. Waste is being disposed of in the forest, by open burning or buried on beaches or left along the shores or dumped at sea.
- Tourism services are at low level. Although there are six guest houses on the CLC islands (3 in Bai Lang; 1 each in Bai Ong, Bai Bim and Bai Chong), the guest houses have few rooms and the facilities are at basic levels and of low quality, so that visitors do not want to spend nights in the island.
- The presence of a big military base in the CLC for security and national defense requires that civilians can only get access within a radius of 200 m above and below the sea. This limits the recreational activities, particularly adventure-related and natural tourism. Some foreign visitors reported of having experienced difficulties in obtaining permission to visit the island.

with focus on meeting specific vulnerability and poverty reduction targets, and gender equality objectives.

The establishment of the CLC MPA plays a very important role in protecting the ecosystems and as such it would only be successful with the active participation of local communities in all the steps from the planning stage until the implementation of the various activities. Considering that many local inhabitants are not aware of their high dependencce on the natural resources, their participation in the MPA gives them the opportunity to be responsible in resource management and to actively look for alternative options to improve their livelihoods and income.

Issues and Concerns

A conservation network has been established with four units at the villages in CLC in order to support the patrol activities as well as to raise awareness on the MPA. The units were formed by the peoples' committee with members working for and receiving payments from the MPA project. Such arrangement provides confusion as to how the units could be effectively managed and under which administrative mechanism the units would operate. Most members of the units are mostly government officers and do not represent the fishing communities. However, most of the unit members were engaged in the MPA community development in the first stages of the MPA so they would be familiar with the concept of an MPA, had worked with the communities and must have already gained their trust. A good management system for the units would have improved the effectiveness of the implementation of a community-based model for MPA management.

Support has also become considerably less for the CLC MPA club which was established in 2003 by the MPA project comprising people from Tan Hiep commune. The establishment of MPA club in Cu Lao Cham archipelago plays a very important role in enhancing the responsibilities of local inhabitants in resource management as well as their participation in other social activities. Thus, the members of the MPA club were chosen to comprise the heads of villages, and were mainly responsible in promoting, encouraging and launching environmental protection campaigns. The club also provides opportunities for local inhabitants to share their opinions on how to improve the effectiveness of the environmental management systems of the Cu Lao Cham MPA.

The Club has contributed largely and effectively at the local level as major facilitator of all the MPA related activities. But there has not been a clear management mechanism and financial incentive for the Club in its three years existence under the MPA project. However, it can also be gleaned that the Club members' ability and awareness in conservation activities had been greatly enhanced. In spite of such constraints, the Club continues to be responsible for other important tasks such as facilitating the implementation of the MPA Management Board activities, conducting vocational training courses, and managing the Visitors Center. In order to fully acknowledge the roles and ability of the MPA club, the members should be provided the necessary support including the possibility of establishing a policy on reward system and other financial incentives for the Club to improve its performance. The initial budget to fund the community-based management units could be sponsored by the LMPA component, and funds could be subsequently allocated for this purpose from the tourism revenues more particularly from the income of the Visitors Center.

A volunteer network was also set up in CLC community comprising volunteer students from regional universities. The network has been helping the MPA office with the on-site field surveys and in interviewing local people to get feedbacks and comments on the implementation of the MPA. The global volunteer network (GVN) also re-opened its English classes with new volunteer teachers and with courses that have been adjusted based on the facilitators' recommendations. These are steadily progressing and should be fully supported by the MPA Project.

Conclusion and Recommendations

The CLC MPA has been divided to three zones, namely: the restricted zone (the core zone), recovery zone, and the development zone. Protection activities for the restricted and recovery zones are aimed to maintain the large ecosystem for ecological tourism and for fisheries in the development zone. In an effort to fully understand the importance of MPAs, local inhabitants voluntarily participate in guarding and patrolling the restricted zones as well as in preventing illegal and other forms of resource exploitation in the development zone.

Various environment-friendly livelihood activities are being promoted in the development zone. Ecological tourism is one of the development strategies in the CLC MPA, providing significant income for local inhabitants through the different types of environmental services. Cultural activities supporting the ecological tourism also play important roles in community development in Bai Lang and Bai Huong villages. Thus, the development of different livelihood activities is expected to reduce pressure on the marine resources and alleviate poverty among the local inhabitants. Based on the results of the study, it can be deduced that community-based resource management is appropriate for the sustainable development of the CLC MPA. The CLC MPA has enhanced local capacity through

the people's active participation in social activities, which helped in poverty alleviation in coastal villages.

Lessons from the community-based resource management system in Cu Lao Cham archipelago could be adapted for establishing new or managing other existing MPAs in Vietnam. Recommendations for the establishment of MPAs, based on the study, include the following:

- The establishment of MPA should strongly emphasize in reducing the vulnerability of poor families living in small fishing communities.
- Communities are encouraged to take full and active involvement in the management of the MPA through community-based organizations, integrated management and feedback mechanisms.
- MPAs should be focused on increasing awareness and understanding of marine resource protection and the role of the MPAs in enhancing sustainable livelihoods.

References

Annual report and quarter reports of LMPA Cu Lao Cham 2006 and 2007. Reports to LMPA component.

Ashton, E.C, 2005. Aquatic resources utilization around the Cu Lao Cham islands

DANIDA, 2003. Support to the marine protected area network in Vietnam

Ha Minh Tri, 2007. Báo cáo khảo sát nhóm đối tượng đích chương trình thí điểm hỗ trợ sinh kế thay thế có sự tham gia của cộng đồng. Hợp phần hỗ trợ sinh kế cho cộng đồng bên trong và xung quanh khu bảo tồn biển 2006-2010 (LMPA).

MOFI, DANIDA and WWF, 20007. Field report Cu Lao Cham Marine Protected Area. A report for LMPA component.

Nguyen Ngoc Phuoc, 2007. Quarterly consultancy reports of LMPA Cu Lao Cham. Reports to LMPA component.

The Vietnam-Denmark project, 2004. Sustainable Livelihoods in and around Marine Protected Areas.

Vo Si Tuan, Nguyen Van Long, Hua Thai Tuyen, Phan Kim Hoang, Nguyen Xuan Hoa, Pham Van Thom, Pham Huu Tam and Hans Dilev, Reno Linberg. 2004. Marine habitats and resource survey of Cu Lao Cham Marine Protected Area, Quang Nam Province, Vietnam

About the Authors

Nguyen Ngoc Phuoc is the Vice-Dean of the Faculty of Fisheries, Hue University of Agriculture and Forestry, 102 Phung Hung, Hue, Vietnam. Email: n2phuoc@gmail.com

Nguyen Giang Thu is the Vice - Director of the Science, Technology and Environment Department, Ministry of Agriculture and Rural Development, 2 Ngoc Ha, Hanoi, Vietnam. Email: giangthu@gmail.com

Ta Thi Thanh Huong is a PhD student at the University of Manitoba, Winnipeg, Manitoba, Canada. Email: tahuong@gmail.com

Reducing the Impacts of Fishing Activities on Coastal and Marine Environments in the Southeast Asian Waters: A Regional Synthesis

Worawit Wanchana, Bundit Chokesanguan and Virgilia Sulit

Many traditional fishing activities have been found to induce negative impacts on the coastal and marine environments as well as on the resources. In an effort to assess the extent of such impacts, SEAFDEC convened in January 2009 a workshop to address the concerns on the need to improve the designs and use of fishing gear in order to address the impacts of using such gear on the coastal and marine environments as well as mitigate sea turtle by-catch in fisheries. This article includes the initiatives of the Southeast Asian countries in reducing the impacts of fishing practices on the marine environments and resources.

Concerns regarding the effects of fishing on the marine and coastal environments have been seriously discussed worldwide. Guided by the policy framework on sustainable fisheries for food security, the Southeast Asian Fisheries Development Center (SEAFDEC) in collaboration with the SEAFDEC Member Countries and other relevant organizations had been "working towards the conservation and rehabilitation of aquatic habitats essential to enhancing fisheries resources" (Para 9: Resolution on Sustainable Fisheries for Food Security for the ASEAN Region 2001). In this regard, SEAFDEC has been promoting the development and adoption of responsible fishing gear and practices in the Southeast Asian waters that aim to minimize the impact of fishing to the coastal and marine environments (SEAFDEC, 2000 and SEAFDEC, 2003). Such initiatives by SEAFDEC have been demonstrated through the implementation of various activities that include a number of R&D activities on turtle excluder devices (TEDs), Juvenile and Trash Excluder Devices (JTEDs) as well as human capacity building on topics related to the use of selective fishing gear and devices and promotion of the concept on fisheries refugia (SEAFDEC, 2006).

Moreover, minimizing the incidental catch of threatened marine species such as sea turtles, dolphins and other species which could be included in CITES Appendix 1 and 2 is

also being promoted by SEAFDEC. In the Southeast Asian region, it is a fact that there is a dearth of information on the current status of sea turtles and the factors that led to their high mortalities, even considering that activities related to the collection of information of sea turtles mortality has been initiated and conducted through various initiatives. Considering such realities, SEAFDEC has also embarked on activities that assess the impacts of fishing on the sea turtle resource.

Reducing the Impacts of Fishing Activities in Southeast Asian Waters

Within SEAFDEC, reducing the impact of fishing to the environment and resources has been one of the major key issues in its activities that aim to boost sustainable fisheries development in Southeast Asia. In order to provide a forum for experts from Southeast Asia and Japan to exchange information and discuss activities related to the reducing the impact of fishing, SEAFDEC conducted the Regional Workshop on the Reduction of the Impact of Fishing in Coastal and Marine Environments in the Southeast Asian Waters in January 2009. In addition, discussion on the need to improve the various designs and uses of the fishing gear was also conducted while initiatives and efforts made by the countries in the region to mitigate the impacts of fishing on the coastal and marine environments were collated and summarized.

Brunei Darussalam

The country has been exerting efforts to reduce the impact of fishing in coastal and marine environments and address the concern on the over-exploitation of the country's marine resources especially the capture fishery resources that have started to show symptoms of fatigue from fishing. The country's activities include the adoption of JTEDs and mesh size regulation (51 mm^2 mesh at cod-end), and imposing a moratorium on the issuance of new licenses for demersal trawlers starting in 2000 as well as for small-scale capture fishing operations in Zone 1 (0-3 nautical miles). Through its Department of Fisheries (DOF), Brunei Darussalam continues to pursue its campaign in regulating capture fisheries in various possible ways one of which is the use of excluder devices not only for trawlers but also for other types of fishing gear to minimize the continuous capture of by-catch that includes the juveniles of commercially important fishes. Specifically, the "Moratorium" on fishing operations in Zone 1 area is aimed at giving opportunities for local fishermen dependent on the resources in Zone 1 to improve their livelihood, giving chance for the fishery resources to recover and be sustainable for a long period of time, reducing the pressure on the fish breeding and spawning areas that include the Brunei Bay (Teluk Brunei), and ensuring that the exploitation of the fishery resources remains at sustainable level. The "Moratorium" involves transferring the operations of fishing companies with foreign fishers from Zone 1 to Zone 2 (3-20 nautical miles), suspension of licenses for new fishing gears that exceeds the allowable limit, and placing the new part-time fishermen and applicants in companies to Zone 2. In order to sustain such regulations, the DOF of Brunei Darussalam adopts strategies that include the gradual phasing out of trawl, mesh regulation by gear types, continuous monitoring of CPUE and fish production, and coastal area management. Moreover, the DOF stand on strict enforcement is being demonstrated through more vigilant actions of the appropriate authorities.

Cambodia

Reducing the impact of fishing on the coastal and marine environments in Cambodia covers a much wider scope of activities, such as: registration system for all kinds of fishing boats/gears, licensing system (for boats and fishing gears), elimination of trawling boats in coastal areas (area < 20 m-depth), establishment of a clear definition of "landing sites", and improving control and monitoring systems. In addition, a number of initiatives have been promoted that include: establishment of Community Fisheries (CF) in coastal areas, protection of the resources by defining the type of fishing gears and controlling the use of destructive fishing gears, rehabilitation of the degraded coastal resources and the ecosystems through a Management Strategy Plan which includes co-management of the fishery resources and fisheries conservation strategies such as the installation of artificial reefs, establishment of seasonal protected refugia. Furthermore, the Alternative Livelihood Program for Fishers has been promoted covering small-scale coastal aquaculture development, enhancement of post-harvest skills, integrated fisheries-livestock-raising and other employment skills. Moreover, the Development of the Coastal Area has also been promoted to advance not only industrial investments in the coastal areas but also recreational activities (resort and hotel industry) and ecotourism. In this connection, the Fisheries Administration of Cambodia has started to build the capacity of institutions and human resources of which the specific activities include information collection, management and analysis of fishery resources as well as further strengthening of its capacity in research, fisheries management, conservation and law enforcement.

Indonesia

Since the tidal traps are widely used in Indonesia, the possible replacement of the Tidal Traps with the Set Net has been considered since tidal traps also catch the juveniles of economically important fishes in addition to unwanted

Photo: Zarochman, 2009)

catch. This is part of the country's efforts in undertaking activities that are aimed at maintaining the fisheries habitat by minimizing habitual unsustainable fishing activities such as the use of tidal traps. There are two types of tidal traps (stationary fishing gear) commonly used in the country, namely: with leader net for catching various species of fish and without leader net used mainly to catch shrimps. Tidal traps with leader net or stake set-nets are operated at limited shallow waters close to the coastline during the tides while tidal traps without leader net are operated mainly during periods of rising tide and target mainly shrimps and fishes of various species and sizes. Tidal traps without leader net and without wings are operated in narrow straits or around estuaries. Being stationary, the stake set-nets operated in critical water areas also catch the small sizes of various fish species and thus, are considered menace to the fishery resources. Considering that the operation of tidal traps and tidal nets in critical water areas that serve as spawning, growing and nursery grounds of various marine species is unsustainable, measures are being undertaken to manage the resources with emphasis on the management of water resources and regulating the use the tidal traps or similar gears. An option being considered in the country is the promotion of the Japanese type of set-net to substitute the stick set net (tidal traps with leader net).

Malaysia

Malaysia had enforced regulations on the use of destructive fishing gear and practices, fisheries zoning, reduction of fishing capacity of trawlers in coastal waters, protection and conservation of critical areas, and protection and rehabilitation of destroyed habitats. Among the activities undertaken by the Department of Fisheries Malaysia include experiments on JTEDs, selection device for the Acetes Trawl (known as the Malaysian Acetes Efficiency Device or MAED), and assessment on the impact of "pukat buaya" (trawl net with large mesh size of wing). The MAED is designed to retain almost all of the Acetes in the cod-end which could pass through the slanting filter while most of the by-catch such as fish and jelly fish that could not pass through the filter are guided and released through a special opening. The filter is collapsible so it could be hauled in the net drum. The protection of the critical habitats is a major concern in Malaysia to ensure the conservation of the environment, including aquatic flora and fauna and their habitats, and natural breeding grounds like mangrove areas. This effort is being promoted through the Establishment of Marine Parks and Prohibited Fishing Areas. At present there are 40 marine parks in Malaysia, where habitat rehabilitation includes the installation of artificial reefs using used tires, junked vessels, and designed concrete structures which also serve as protection for habitats and breeding grounds for fish.

Myanmar

Myanmar focuses its efforts in the assessment of the impact of the trawl fishery production system on the environment and resources specifically on the hilsa and pomfret fishery resources. The country's efforts include the conduct of studies on the economic value of by-catch and discards as well as on the development of by-catch reduction technologies in collaboration with SEAFDEC, introduction of alternative fishing methods following the responsible fishing technologies and practices, promotion of the successfully developed by-catch reduction devices (BRDs) through training and extension services, and development of the necessary legal and management framework. In addition to the campaign on the use of TEDs and JTEDs in collaboration with SEAFDEC, management measures are also being advanced that include imposing closed season, restriction on mesh size, and banning of illegal fishing methods. However, the country still needs to strengthen its management measures to control fishing efforts and enhance its rehabilitation and conservation activities while regulations related to the reduction of impact of fishing activities and conservation in fisheries resources need to be strengthened.

Philippines

In the Philippines, Republic Act No. 8550 also known as the Philippine Fisheries Code of 1998 covers policies related to the utilization, management, development, conservation and allocation system of fisheries and aquatic resources as well as establishment of Municipal and Commercial Fisheries. Specifically, the policies also provide that municipalities and city governments have jurisdiction over municipal waters (0-15 km), define the role of the FARMCs (Fisheries and Agriculture Resources Management Centers) in the enactment of ordinances, and authorize the local government units (LGUs) to enforce fishery laws and regulations. Moreover, the policies also specify the provisions on vessel licensing and registration, registration and licensing of fishing gears, incentives for fishing further into the EEZ and also the implementation of the Philippine Management Plans such as the Tuna Management Plan that regulates the tuna purse seine mesh size, limits the number of fish aggregating devices (FADs) and monitors fishing vessels; the Sardine Management Plan that includes control of fishing capacity, effort, season, areas, and catch of immature fish; and the Comprehensive National Fisheries Industry Development Plan.

Thailand

Focus has been made in Thailand to regulate the use of light fishing and collapsible crab traps (**Box 1**) as these practices are known to have impacts to the environment and marine waters as well as also regulating the use of clam dredging gear. Furthermore, Thailand collaborated with SEAFDEC/TD to explore various alternative energies for fisheries that include the use of sail for fishing boats and natural gas in order to reduce the impact boat engines and fuel to the environmental as well as the effect of increasing cost of fuel on the fishers. This is also considering the fact that the use of wind energy for fishing boat could replace the energy requirement for engine boats while natural gas could also be used for fishing vessels. Moreover, Thailand also promoted the use of the Set-Net fishing technology for sustainable coastal fisheries management which was started in Rayong Province. The technology was transferred later to Chonburi Province (Thailand) and Bone in Indonesia, and perhaps later to other Southeast Asian countries.

Vietnam

The fishing vessels in Vietnam are small and operate in inshore areas, and most fishing fleets are traditional and lack of modern fishing equipments. In the midst of such constraints, Vietnam is exerting efforts to reduce the impacts of fishing on the coastal/marine habitats as reflected in Decision 10/2006/QD-TTg dated 11January 2006 of the Prime Minister specifically the approval of the comprehensive master plan of fisheries sector by 2010 and orientation by 2020. Moreover, Government decree no. 123/2006/NĐ-CP dated 27 October 2006 provides the management of fishing activities of organizations and individuals in Vietnam's seawater areas. Moreover, Vietnam is monitoring the use of deep gill net that catches the Manta Ray (CITES species) and is enhancing its efforts in reducing the impact of fishing activities especially in the marine protected areas through the development and adoption of JTEDs, among others.

Reducing the Impacts of Fishing Practices: The Case of Japan

In Japan, various types of light fishing are practiced specifically for angling gear (*e.g.*, squid jigging, pole and line, hook and line) and net gear (*e.g.*, scoop net, stick-held lift net, purse seine). Different light intensities are used in different fishing grounds targeting a number of marine

Box 1. Light fishing and use of collapsible crab traps in Thailand

Light Fishing. In the upper Gulf of Thailand, light fishing is one of the most common operations adopted by the fishers believing that increasing the light sources could aggregate more fishes. The fishers are not aware that increasing the light source could lead to increased investment costs especially with the current increase in fuel prices. Fishing lamps such as incandescent lamps, metal halide lamps or fluorescent lamps are commonly used with fishing gears, e.g. surrounding net, lift net and falling net. However, the total radiant energy from the light source loses half of its value in the half meter depth of seawater, owing chiefly to the strong absorption in the infrared and of the suspended particles. Specifically in the upper Gulf of Thailand, the level of suspended particles is reported to be dense near the river mouth and coastal areas but decreasing in the offshore areas. Moreover, results of the study which considered the impacts of anchovy and squid light fishing on the coastal and marine environments including the color and intensity of the light, especially on the biodiversity (by-catch), indicated a form of light shock reaction behavior in anchovy and light detection by squid. The results therefore suggested that anchovy and squid light fishing which use white color of light could impact the coastal and marine environment in terms of by-catch. Therefore there is a need to develop regulations for light intensity and color for anchovy and squid light fishing that are being operated nearshore.

Collapsible crab traps. Results of the survey conducted by DOF Thailand and SEAFDEC/TD in the eastern part of Thailand (Rayong, Chantaburi and Trad Provinces) indicated that collapsible crab trap operations had little or no direct impact to the fisheries resources. However, in order to mitigate the impact of such fishing activity, SEAFDEC/TD suggested that the cover mesh size of the traps operating near the shoreline should be enlarged. In addition, zoning to limit the operation of the collapsible crab traps used by commercial boats should be initiated and regulations on large mesh size traps for inshore operations should also be imposed. On the other hand, considering that abandoned crab pots and traps could induce ghost fishing, efforts should be made to collect all crab traps that have been used in previous fishing operations.

species. Research studies on catch comparison among the different light outputs have been conducted including the analysis of fishing efforts and catch, underwater light intensity, and monitoring the capture processes. The impact from light fishing could include lighting power competition (effect to other boats in a congested fishing ground and to small-scale fisheries in the coastal areas), cost impact due to high fuel consumption, environmental impact due to CO_2 emission, and biodiversity impact (non species/size selective as in the case of purse seine).

Research studies have also been conducted to evaluate the impact of light fishing which includes monitoring of underwater light intensity, understanding fish responses to light, and comparative experiments with different lighting outputs. In addition, reducing the light output has also been explored using LED (light emitting diode) for squid jigging boat and for the underwater lamp of purse seine. Thus, the technology of light fishing that should be disseminated to the other countries could include: (1) optimum lighting technology; (2) reasonable cost for initial investment and fuel consumption; (3) clever light fitting for fishing boats and gear; (4) clever light fitting for target species and size; and (5) promotion of user-friendly technologies.

Regional Network for the Reduction of the Impact of Fishing in Coastal and Marine Environments in Southeast Asian Waters (IFCOME Network)

In line with the efforts of the ASEAN Countries to reduce the impact of fishing practices to the coastal and marine environments, the establishment of the IFCOME Network has been proposed to facilitate the sharing and dissemination of information on programs and initiatives related to the reduction of the impact of fishing, and monitor the developments to be used as basis in improving the design of fishing gears and promotion of responsible fishing practices. The main role of the IFCOME Network is to provide information and recommendations that could contribute to: (1) improving the current fishing gear technology and its actual practices to reduce the impacts from fishing activities; (2) enhancing inter-agency and inter-sectoral coordination at the national, regional and international levels for achieving sustainable fisheries management and development in the Southeast Asian region through proper development of fishing gear technologies and practices; (3) strengthening regional cooperation on R&D, technology transfer, and resources capacity building on the issues related to reduction of impact of fishing practices; and (4) widening the network of people, government, organizations for reducing the impact of fishing practices to the coastal and marine environments.

Status and Trends of Sea Turtle Interactions: Degree of Risks each Fishery Poses to Sea Turtles

SEAFDEC has been conducting studies aimed at mitigating the interaction and reducing the mortality of sea turtles due to fishing, which include the development and application of the turtle excluder devices (TEDs) and assessment of the efficiency of the Circle Hook compared with the J-hook in long-line fishing. Technical consultations on the progress of the initiatives in reducing sea turtle mortalities from fishing have also been conducted while production of information packages and conduct of awareness building campaigns on the conservation and management of sea turtles has been enhanced. The impact of trawling on sea turtles has also been monitored to establish the necessary management measures for the conservation of the sea turtles. SEAFDEC also implements activities related to the inter-nesting habitat of sea turtles in Southeast Asia focusing on satellite telemetry study and tagging of sea turtles with the main objective of gathering information on the migration pattern of sea turtles in the region. Results have shown the inter-nesting habitat, *i.e.* the area and period where the occurrence of sea turtles, are very closed to shore and that small scale/traditional fishing gears could cause high potential mortalities on turtles. Moreover, the use of traditional gears such gill and drift nets are among the major fishing activities in the inter-nesting habitat in the region while mini trawls have also been reported to be possible threats to the sea turtles in the inter-nesting habitat. Furthermore, the use of stow-net which is a popular fishing operation in the inter-nesting habitat of sea turtles (particularly in Myanmar) could also cause mortalities on sea turtles. In this connection, SEAFDEC suggests that innovations in the gear technology should be enhanced in order to minimize sea turtle mortalities in the region's sea waters.

In a related activity, in Indonesia an onboard observation program on shrimp trawlers and bottom long-line demersal fishing boats is being carried out to observe the impact of fishing operations on sea turtles as well as on the promotion and implementation of circle hook for long-line fishing. On the other hand, the results of the Rapid Assessment of By-catch in Sabah (Malaysia) indicated that by-catch from fishing operations includes the sea turtles, dugong and assorted cetaceans. In Thailand, an Act has been legislated concerning sea turtles conservation.

Furthermore, SEAFDEC is also conducting a study to investigate the impact of fish aggregating devices (FADs) on sea turtle mortality in the Eastern Indian Ocean. FADs are usually installed to lure tuna and other fishes but sometimes the FADs endanger the marine species such as sea turtles that could be entangled especially in the drifting

FADs (DFADs). In view of such developments, SEAFDEC raised some considerations on the use of FADs that include: abandonment of FADs in the oceans should be prohibited, the net materials used to construct the DFADs should be modified, and that the use of small mesh size nets and large twines for the FADs should be promoted. Moreover, the use of coconut leaves for the FADs could also be considered.

Summary Recommendations and Follow-up Actions

Considering that the following fishing practices could bring about negative impacts on the coastal and marine environments especially in the Southeast Asian waters, namely: (1) light fishing; (2) use of stationary gears (*e.g.*, tidal traps, stow-net, fyke net, Japanese set net, muro-ami, choko-ami, etc.); (3) use of active gears (*e.g.*, trawls, dredge, push net, etc.); (4) use of semi-passive gear and small-scale fishing gear (*e.g.*, pot, gill net, etc.); (5) long-line fisheries; and (6) purse seine operations associated with FADs, actions have been proposed to mitigate such impacts (**Box 2**) at the regional and national levels. Moreover, the action plan for

Box 2. Regional Action Plan for the Reduction of the Impacts of Fishing on the Coastal and Marine Waters in Southeast Asia

Gear Type	2009 Action Plan	Three-Year Action Plan	Final Goal

Light Fishing	• Survey of present status of light fishing in Southeast Asia for each target/gear/area (already initiated in Thailand, to be conducted in Indonesia and Malaysia under JTF)
	• Literature review on status of light fishing in Southeast Asian countries
	• Regional expert meeting for setting the research project framework (Oct or Dec @ KU)
	• Technical meeting on light fishing technology
		• Collaborative research programs on fishing technology, such as:
		  • Visual Physiology
		  • Optical Oceanography
		  • Monitoring of fish response
		  • Socio-economics
		  • Optimum lighting in fishing
		  • Saving energy of light
		  • Develop best practices
		  • Draft appropriate policy
		  • Transfer technology
			• Optimization of lighting output for specific target/gear
			• Preparation of technical/management manual
			• Development of appropriate policy for Southeast Asia
			• Reduction of social and resource use conflicts, and promotion of zoning

Stationary Gear, such as :
Tidal Trap
Stow/Fyke net
Japanese type Set-net
  Otoshi-ami
  Choko-ami
	• Develop technical/management manual on Japanese Set-net
	• Establish regional expert network on set-net in order to promote further extension of set net technology in the region according to national request
	• Implement pilot project on set net in Southeast Asia (Indonesia and Malaysia)
	• Assess the impact of tidal gears (traps/stow nets, tidal nets) in Southeast Asia
	• Regional expert meeting to report progress on set-net in Thailand and Indonesia (Oct or Dec @ KU)
		• Disseminate and promote the manual (model net plan) in some Southeast Asian countries
		• Capacity building of set net experts
		• Develop best practices for stationary gears
		• Implement Extension Phase through a SEAFDEC Regional Training Course for trainers
		• Facilitate the conduct of National Training Course for fishers
			• Adoption of stationary gears based on best practices
			• Publication of manual on best practices for stationary gears
			• Transfer and adoption of the Japanese Set net as alternative gear in selected coastal areas in the region

Active Gear, such as: Shrimp/Fish Trawl Dredge Push net	• Develop strategy on implementation of the use of JTEDs in Southeast Asia • Evaluate and assess the adoption of JTEDs in the Southeast Asian region (Philippines and Indonesia) • Develop observer program for active gears • Further study on the impacts of dredge, push net, etc. operated in coastal areas	• Develop best practices for JTEDs, etc. • Develop Policy Recommendation on the use of dredge and push net in coastal areas	• Adoption of JTEDs based on best practices • Adoption of Policy Recommendation on the use of dredge and push net
Small-scale Gear such as: Gill net Pot/Trap	• Assess the impact of small-scale gears (e.g gill net, pot, trap) to marine bio-resources and marine mammal by-catch • Conduct R&D on mitigation measures for ghost fishing and non-selective gears (e.g. gillnet)	• Promote and implement solution (management) models for small-scale gears • Develop strategy on mitigating impacts of gillnet fishing of marine mammal by-catch • Awareness building on use of non-selective gears in critical habitats	• Strategy on mitigation of marine mammal by-catch in small-scale gears (non selective gears)
Longline	• Develop strategy on the adoption of Circle Hook in longline fishery • Promote best practices for longline fisheries • Develop strategy for market incentives	• Secure reliable supply of appropriate hooks • Implement onboard observer programs in relevant Southeast Asian countries	• Adoption of Circle Hook in longline fishery • Improved information base on longline fisheries • Increased demand for sustainably caught tuna
Purse seine operation associated with FADs	• Conduct inventory survey on FADs (DFADs or Fixed FADs) deployed in Southeast Asian waters • Assess the impact of Fixed FADs to tuna stocks • Improve DFADs to reduce marine mammal by-catch	• Conduct awareness building on the loss of D-FADs and on the use of Fixed FADs in purse seine fisheries • Develop recommendations and best practices for D-FADs and Fixed FADs	• Recommendations and best practices for D-FADs and fixed FADs

Box 3. Alleviating fisheries and sea turtles interactions		
2009 Action Plan	**Three-Year Action Plan**	**Final Goal**
• Conduct awareness/educational programs targeting the fishers and students on the conservation of sea turtles and other endangered species • Regional Technical meeting on sea turtle enhancement and fishery-sea turtle interaction including poaching of sea turtles by MFRDMD • Assess the risk areas in sea turtle-fisheries interaction and identify gear risk to sea turtle mortality	• Conduct experiment on the improvement of fishing gears and methods (such as gill net, set-net) to reduce sea turtle by-catch • Implement regional program on research and management of foraging habitats of sea turtles in the Southeast Asia • Develop recommendations on the management measures to reduce the sea turtle by-catch in the Southeast Asian region	• Adoption of fishing gears and methods (such as gill net, set-net) to reduce sea turtle by-catch • Implementation of regional program on research and management of foraging habitats of sea turtles • Recommendation on the management measures to reduce the sea turtle by-catch in Southeast Asia

Box 4. Proposed operationalization of the IFCOME Network		
2009 Action Plan	**Three-Year Action Plan**	**Final Goal**
• Conduct impact/risk assessment for awareness building in critical habitats (SEAFDEC) • Develop best practices to mitigate the impact of fishing gears • Establish the IFCOME Network • Source funds at regional/ national levels • Conduct Nature-Harmonized Gear Competition for enhancing the R&D for impact reduction	• Enhance awareness through training programs on impact of fishing activities to critical habitats • Implement/communicate through the IFCOME Network	• Awareness building on impact of fishing activities to critical habitats (SEAFDEC) • Adoption of the best practices to mitigate the impact of fishing gears • Regional Network IFCOME established

alleviating the interaction of fisheries with sea turtles has also been developed for consideration by the countries in the Southeast Asian region (**Box 3**). At the regional level, the establishment of IFCOME Network could provide the necessary link for the exchange of information by the countries in Southeast Asia (**Box 4**).

References

Abdullah, Syed. 2009. Overview on fishing activities in the inter-nesting habitat of sea turtles in Southeast Asia. Paper presented during the Regional Workshop on the Reduction of the Impacts of Fishing on the Coastal and Marine Environments in the Southeast Asian Waters, Samut Prakarn, Thailand, 12-15 January 2009

Ali, Rosidi. 2009. Review of some initiatives/programs related to reduction of impacts of fishing gears and practices on coastal and marine environments in Malaysian waters. Paper presented during the Regional Workshop on the Reduction of the Impacts of Fishing on the Coastal and Marine Environments in the Southeast Asian Waters, Samut Prakarn, Thailand, 12-15 January 2009

Arimoto, T. and Monton, A. 2009. Resource conservation and management in tropical areas. Paper presented during the Regional Workshop on the Reduction of the Impacts of Fishing on the Coastal and Marine Environments in the Southeast Asian Waters, Samut Prakarn, Thailand, 12-15 January 2009

Arimoto, Takafumi. 2009. Impact of Light Fishing: Experiences in Japan – How to Stop the Light War? Paper presented during the Regional Workshop on the Reduction of the Impacts of Fishing on the Coastal and Marine Environments in the Southeast Asian Waters, Samut Prakarn, Thailand, 12-15 January 2009

Awaiwanont, Kamonpan. 2009. Anchovy and squid light fishing in Thailand. Paper presented during the Regional Workshop on the Reduction of the Impacts of Fishing on the Coastal and Marine Environments in the Southeast Asian Waters, Samut Prakarn, Thailand, 12-15 January 2009

Aye, Khin Maung. 2009. Reduction of the impacts of fishing gear in coastal and marine environment in Myanmar. Paper presented during the Regional Workshop on the Reduction of the Impacts of Fishing on the Coastal and Marine Environments in the Southeast Asian Waters, Samut Prakarn, Thailand, 12-15 January 2009

Chanrachkij, I., Loog-on, A. and Siriraksophon, S. 2009. Sea turtle mortality risk from drifting fish aggregating devices. Paper presented during the Regional Workshop on the Reduction of the Impacts of Fishing on the Coastal and Marine Environments in the Southeast Asian Waters, Samut Prakarn, Thailand, 12-15 January 2009

Dickson, Jonathan. 2009. National initiatives related to the reduction of impacts of fishing gear and practices on coastal and marine environment in the Philippines. Paper presented during the Regional Workshop on the Reduction of the Impacts of Fishing on the Coastal and Marine Environments in the Southeast Asian Waters, Samut Prakarn, Thailand, 12-15 January 2009

Dickson, Jonathan. 2009. Preliminary report on the assessment of the interaction between sea turtles and fisheries in the Philippines. Paper presented during the Regional Workshop on the Reduction of the Impacts of Fishing on the Coastal and Marine Environments in the Southeast Asian Waters, Samut Prakarn, Thailand, 12-15 January 2009

Hung, Pham. 2009. Reduction of the impact of fishing gear in coastal and marine environment in Vietnam. Paper presented during the Regional Workshop on the Reduction of the Impacts of Fishing on the Coastal and Marine Environments in the Southeast Asian Waters, Samut Prakarn, Thailand, 12-15 January 2009

Kittiwattanawong, Kongkiat. 2009. Fisheries interaction with sea turtles in Thailand. Paper presented during the Regional Workshop on the Reduction of the Impacts of Fishing on the Coastal and Marine Environments in the Southeast Asian Waters, Samut Prakarn, Thailand, 12-15 January 2009

Matzainin Haji Juna. 2009. Review on the national initiatives related to the reduction of impacts of fishing gear and practices on coastal and marine environment: Brunei Darussalam. Paper presented during the Regional Workshop on the Reduction of the Impacts of Fishing on the Coastal and Marine Environments in the Southeast Asian Waters, Samut Prakarn, Thailand, 12-15 January 2009

Meksumpun, S., Meksumpun, C. and Ajjimangkul, S. 2009. Impact of fishing gear on bio-resources and coastal environment of Thailand. Paper presented during the Regional Workshop on the Reduction of the Impacts of Fishing on the Coastal and Marine Environments in the Southeast Asian Waters, Samut Prakarn, Thailand, 12-15 January 2009

Monirith, Kao. 2009. Reduction of the impacts of fishing gears in coastal and marine environments in Cambodian waters. Paper presented during the Regional Workshop on the Reduction of the Impacts of Fishing on the Coastal and Marine Environments in the Southeast Asian Waters, Samut Prakarn, Thailand, 12-15 January 2009

Munprasit, A., Srikum, T., Bhuttaruksa, K., Arimoto, T. 2009. Set-net fishing technology transfer for sustainable coastal fisheries management in Southeast Asia. Paper presented during the Regional Workshop on the Reduction of the Impacts of Fishing on the Coastal and Marine Environments in the Southeast Asian Waters, Samut Prakarn, Thailand, 12-15 January 2009

Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region. 2001. SEAFDEC Secretariat, Bangkok, Thailand; 7 pp

SEAFDEC. 2000. Regional Guidelines for Responsible Fisheries in Southeast Asia: Responsible Fishing Operations. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 71 pp

SEAFDEC. 2003. Regional Guidelines for Responsible Fisheries in Southeast Asia: Responsible Fisheries Management. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 69 pp

SEAFDEC. 2006. Regional Guidelines for Responsible Fisheries in Southeast Asia: Supplementary Guidelines on Co-management using Group User Rights, Fishery Statistics, Indicators and Fisheries Refugia. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 84 pp

Symington, Keith. 2009. WWF by-catch strategy in Western Pacific/Coral Triangle: overview of activities and some perspective on regional collaboration. Paper presented during the Regional Workshop on the Reduction of the Impacts of Fishing on the Coastal and Marine Environments in the Southeast Asian Waters, Samut Prakarn, Thailand, 12-15 January 2009

Thubthimsang, Wannakiat. 2009. Value of habitats in the Gulf of Thailand to fisheries. Paper presented during the Regional Workshop on the Reduction of the Impacts of Fishing on the Coastal and Marine Environments in the Southeast Asian Waters, Samut Prakarn, Thailand, 12-15 January 2009

Wanchana, Worawit. 2009. Attitude of fishers on the impacts of their fishing gear and practices: a case study in collapsible crab tarp. Paper presented during the Regional Workshop on the Reduction of the Impacts of Fishing on the Coastal and Marine Environments in the Southeast Asian Waters, Samut Prakarn, Thailand, 12-15 January 2009

Zainudin, Imam Musthofa. 2009. Indonesia on reducing sea turtle by-catch: A progress update (2005-2008). Paper presented during the Regional Workshop on the Reduction of the Impacts of Fishing on the Coastal and Marine Environments in the Southeast Asian Waters, Samut Prakarn, Thailand, 12-15 January 2009

Zarochman. 2009. Tidal traps: their distribution and impacts on fishing in coastal waters and marine environment in Indonesia. Paper presented during the Regional Workshop on the Reduction of the Impacts of Fishing on the Coastal and Marine Environments in the Southeast Asian Waters, Samut Prakarn, Thailand, 12-15 January 2009

About the Authors

Dr. Worawit Wanchana is the Head of Capture Fishery Technology Division, Training Department, Southeast Asian Fisheries Development Center, Samut Prakarn, Thailand

Mr. Bundit Chokesanguan is the Head of Information and Training Division, Training Department, Southeast Asian Fisheries Development Center, Samut Prakarn, Thailand

Ms. Virgilia Sulit is the Managing Editor and member of the Editorial Team of Fish for the People, SEAFDEC Secretariat, Bangkok, Thailand

CALENDAR OF EVENTS

Date	Venue	Title	Organizer
		2009	
28 Sep-2 Oct	Catbalogan, Samar, Philippines	HRD on Poverty Alleviation through Fisheries Intervention: On-site Training on Rural Aquaculture [Abalone Cage Culture]	SEAFDEC/AQD
5-9 October	Bangkok, Thailand	2nd FAO-SEAFDEC Workshops on the Assessment of Fishery Stock Status in South and Southeast Asia	FAO-SEAFDEC/TD
6-7 October	Singapore	Quality Assurance Systems for Small and Medium-sized Fish Processing Establishments in ASEAN Member Countries: End-of-Activity (EOA) Workshop on Good Manufacturing Practices for Traditional Products Establishments	SEAFDEC/MFRD
6 Oct 09-26 Feb 10	TD, Thailand	Training Course on Fishing Vessel Operation for Tinsulanonda Fisheries College	SEAFDEC/TD
12-14 October	Ayutthaya, Thailand	10th SEAFDEC Information Staff Exchange Program (ISEP) Meeting	SEAFDEC/TD
12-16 October	Vientiane, Lao P.D.R	HRD on Poverty Alleviation through Fisheries Intervention: On-site Training on Local/Indigenous Institution and Co-Management	SEAFDEC/TD
12-22 October	TD, Thailand	Short-term Training Course on Fishing Technology for University Student#48	SEAFDEC/TD
13-15 October	Manila, Philippines	Regional Consultative Workshop on Best Practices for Supporting and Improving Livelihoods of Small-scale Fisheries and Aquaculture Households	APFIC
20-22 October	Phuket, Thailand	Meeting of the Sub Regional: Andaman Sea	SEAFDEC/Sida
20-23 October	Boyolali, Indonesia	HRD on Poverty Alleviation through Fisheries Intervention: On-site Training on Rural Aquaculture [Catfish, Clarias gariepinus, Culture]	SEAFDEC/AQD
20-23 October	Boyolali, Indonesia	HRD on Poverty Alleviation through Fisheries Intervention: On-site Training on Inland Fisheries Development	SEAFDEC/MFRDMD
26-31 October	TD, Thailand	Short-term Training Course on Fishing Technology for Ubonrachathani University	SEAFDEC/TD
26 Oct-4 Nov	TD, Thailand	Regional Training Course on Co-management Using Group User Rights for Enhancing Small-scale Fisheries Development and Management	SEAFDEC/TD
3-6 November	TD, Thailand	Inception Workshop on By-catch Management and Reduction of Discard in Trawl Fisheries	FAO-SEAFDEC/TD
3-20 November	TD, Thailand	Individual Training Course on Tuna Long-line Fishing	SEAFDEC/TD
5-7 November	TD, Thailand	Regional Workshop on Institutional Design of Co-management for Promotion of Using Indicators and Participation	SEAFDEC/TD
7-12 November	Brunei Darussalam	31st Meeting of the ASEAN Ministers on Agriculture and Forestry (and related meetings)	ASEAN
11-13 November	Champasak, Lao PDR	10th Annual Mekong Fisheries Technical Symposium	MRC
11-17 November	Preah Sihanouk Province, Cambodia	HRD on Poverty Alleviation through Fisheries Intervention: On-site Training on Rural Aquaculture [Nursery and Grow-out of High-Value Species: Seabass, Grouper, Snapper, Mudcrab]	SEAFDEC/AQD
16-18 November	Kota Kinabalu, Malaysia	32nd Meeting of SEAFDEC Program Committee	SEAFDEC
16-22 November	Myanmar	HRD on Poverty Alleviation through Fisheries Intervention: On-site Training on Rural Aquaculture [Mudcrab and Tilapia Culture]	SEAFDEC/AQD
19-20 November	Kota Kinabalu, Malaysia	12th Meeting of the ASEAN-SEAFDEC Strategic Partnership (ASSP) of the Fisheries Consultative Group (FCG)	SEAFDEC
23-29 November	Ayeyarwaddy, Myanmar	HRD on Poverty Alleviation through Fisheries Intervention: On-site Training on Inland Fisheries Development	SEAFDEC/MFRDMD
24 Nov-17 Dec	TD, Thailand	International Training Course on Coastal Fisheries Management and Extension Methodology	SEAFDEC/TD
Nov-Dec (Tentative)	Tien Hai,Thai Binh Province, Vietnam	HRD on Poverty Alleviation through Fisheries Intervention: On-site Training on Rural Aquaculture [Freshwater Aquaculture: Tilapia, Freshwater Prawn, Catfish, Carp]	SEAFDEC/AQD
Nov-Dec (Tentataive)	Kuala Terengganu, Malaysia	HRD on Poverty Alleviation through Fisheries Intervention: On-site Training on Rural Aquaculture [scope to be identified]	SEAFDEC/AQD
16-18 December (tentative)	Bangkok, Thailand	Regional Technical Consultation on Fishery Information and Statistics	SEAFDEC

Southeast Asian Fisheries Development Center (SEAFDEC)

What is SEAFDEC?

SEAFDEC is an autonomous intergovernmental body established as a regional treaty organization in 1967 to promote sustainable fisheries development in Southeast Asia.

Mandate

To develop the fisheries potential of the region by rational utilization of the resources for providing food security and safety to the people and alleviating poverty through transfer of new technologies, research and information dissemination activities

Objectives

- To promote rational and sustainable use of fisheries resources in the region
- To enhance the capability of fisheries sector to address emerging international issues and for greater access to international trade
- To alleviate poverty among the fisheries communities in Southeast Asia
- To enhance the contribution of fisheries to food security and livelihood in the region

SEAFDEC Program Thrust

- Developing and promoting responsible fisheries for poverty alleviation
- Enhancing capacity and competitiveness to facilitate international and intra-regional trade
- Improving management concepts and approaches for sustainable fisheries
- Providing policy and advisory services for planning and executing management of fisheries
- Addressing international fisheries related issues from a regional perspective

SEAFDEC Addresses

Secretariat

P.O. Box 1046
Kasetsart Post Office
Bangkok 10903
Thailand
Tel:(66-2)940-6326
Fax: (66-2)940-6336
E-mail:secretariat@seafdec.org
http://www.seafdec.org

Training Department (TD)

P.O.Box 97
Phrasamutchedi
Samut Prakan 10290
Thailand
Tel:(66-2)425-6100
Fax:(66-2)425-6110 to 11
E-mail:td@seafdec.org
http://www.seafdec.or.th

Marine Fisheries Research Department (MFRD)

2 Perahu Road
off Lim Chu Kang Road
Singapore 718915
Tel: (65)6790-7973
Fax: (65)6861-3196
E-mail:mfrdlibr@pacific.net.sg
http://www.fishsafetyinfo.com

Aquaculture Department (AQD)

Main Office: Tigbauan,
5021 Iloilo, Philippines
Tel: +63 33 511 9171
Fax: +63 33 511 8709, 511 9170
Manila Office: Rm 102 G/F
Philippine Social Science Center (PSSC)
Commonwealth Avenue, Diliman
Quezon City 1101 Philippines
Tel & Fax : (63-2) 927-7825
E-mail: aqdchief@seafdec.org.ph
http://www.seafdec.org.ph

Marine Fishery Resources Development and Management Department (MFRDMD)

Taman Perikanan Chendering,
21080 Kuala Terengganu, Malaysia
Tel: (609)616-3150
Fax:(609)617-5136
E-mail: seafdec@seafdec.org.my
http://www.seafdec.org.my

In the occasion of the Millennium Conference, a drawing contest was organized for the children among ASEAN-SEAFDEC Member Countries, on the theme of "*Fish and the Culture*". This is the drawing from Japan.