FISH for the PEOPLE

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

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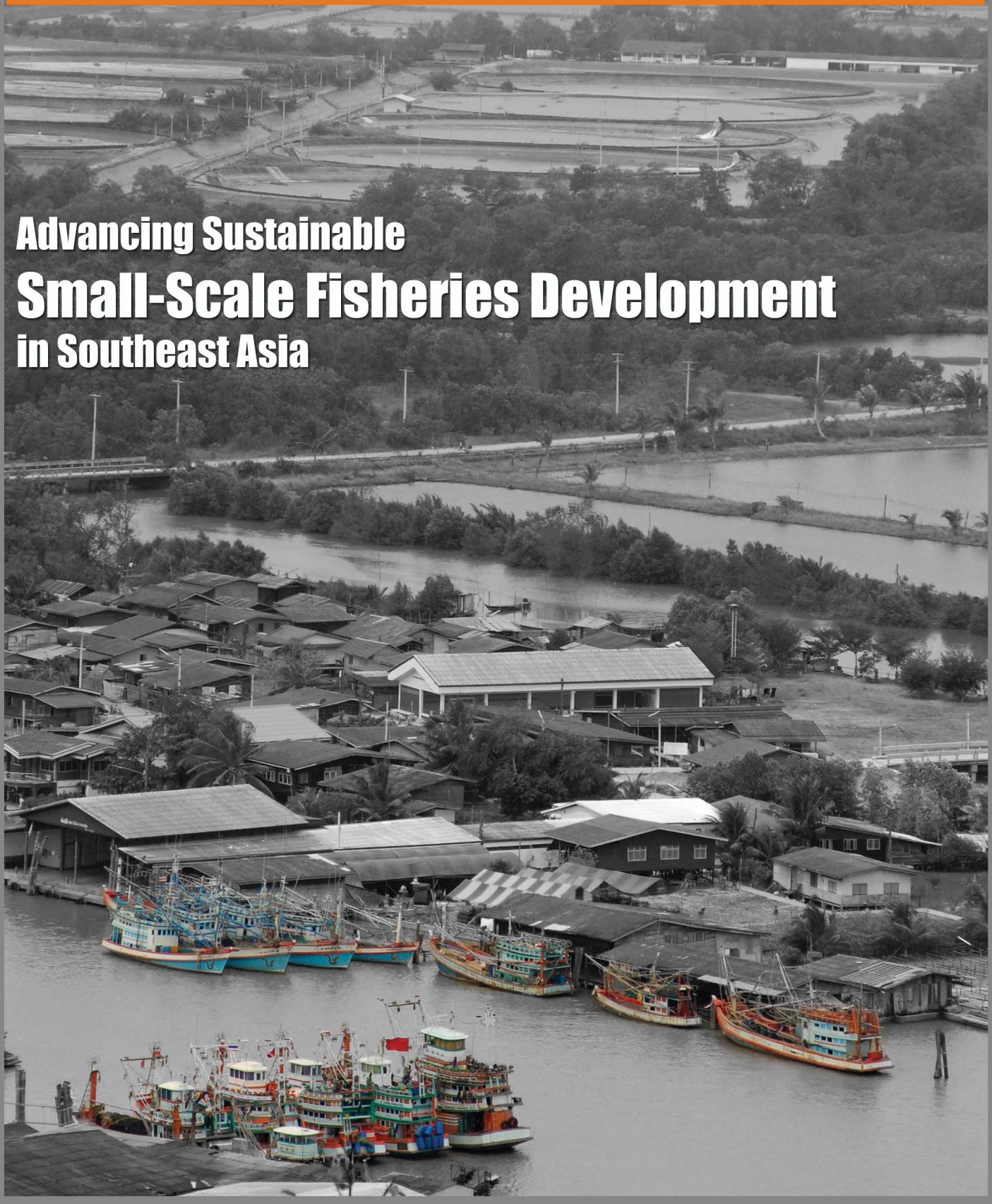

Advancing Sustainable Small-Scale Fisheries Development in Southeast Asia

Southeast Asian Fisheries Development Center

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Editorial

Small-scale fisheries (SSF), which account for at least 40% of the world's total fish production, have been a major source of animal protein, income and employment for many peoples in the developing countries including the Southeast Asian region. In fact, fish constitutes more than 50% of the total animal protein intake of many peoples in developing countries where more than 2.5 billion people rely on fish for their dietary protein requirements. Considering that about 60% of the total food fish production is provided by the developing countries, fisheries therefore, particularly the SSF, play a vital role in ensuring food security in these countries. Despite the importance of SSF in terms of poverty alleviation and economic development particularly in the Southeast Asian region, it has not been given much attention in many regional and international instruments. Issues that concern SSF for example, have not been given much focus in the global Code of Conduct for Responsible Fisheries (CCRF) and in other related instruments.

The Southeast Asian Fisheries Development Center (SEAFDEC) has initiated a program since 1998 on the Regionalization of the CCRF and published from 2000 to 2006 the Regional Guidelines for Responsible Fisheries, which mainly aimed at identifying and prioritizing areas in the global CCRF that would require special consideration at the regional context. In the development of such Regional Guidelines, SEAFDEC looked into the specific situations in the Southeast Asian region that would support the adoption of the CCRF at the regional and national levels. These included the region's cultural situation, fisheries structure and ecosystem. Since most international instruments target mainly the large-scale sectors, the said Regional Guidelines tried to some extent, to focus on the SSF which constitute a major part of the fisheries sector in the region. Since then, SEAFDEC has continued to intensify its efforts in advancing the sustainable development of SSF in Southeast Asia.

At the global scene, discussions on SSF issues have always continued. However, it was only during the Committee on Fisheries (COFI) meeting in March 2007 that the call of the

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developing countries to support the sustainable development of SSF has been heeded. During that meeting, FAO was asked to continue working on SSF issues specifically highlighting on the importance of integrating SSF into all aspects of fisheries. Thus, the development of a Global Dedicated Program on SSF was spawned.

In order to promote the development of such Global Program on SSF, the Regional Fisheries Bodies Secretariat Network (RSN) through the Regional Fisheries Bodies working on SSF promoted the collection of information on SSF through the global dedicated SSF website which is initially operated by SEAFDEC. Thus, SEAFDEC being part of the RSN is compiling information on the status and development of SSF particularly in the Southeast Asian region and uploading such information in the global dedicated SSF website. This is expected to provide the momentum from other RSN members to also establish their respective regional information on SSF.

Having worked on SSF in the Southeast Asian region, SEAFDEC agreed to coordinate the initial establishment of the said global dedicated website at its Secretariat Headquarters in Bangkok, Thailand. The global dedicated SSF website serves as a tool to identify the potential issues and concerns for the Global Program on SSF that the global society could pay more attention to. It has been developed also to promote awareness building using diversified information by various regions in the world on ideas/initiatives related to the development of SSF and exchange information on identified topics and program(s) to be considered as relevant areas for the global SSF program. The dedicated website is also envisaged to raise worldwide awareness on the collection of global information on SSF, with the RSN serving as the forum in promoting the exchange of information on matters related to SSF. Fisheries administrations worldwide, the fisherfolk and all those concerned with SSF are therefore encouraged to exchange their experiences and views on the sustainable development of SSF through the website (http://www.rsn-ssf.net).

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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.

Beyond Winning the Margarita Lizárraga Medal Award for the Biennium 2006-2007

In November 2007, SEAFDEC received the Margarita Lizárraga Medal Award for the Biennium 2006-2007 for having "served with distinction in the application of the Code of Conduct for Responsible Fisheries." The FAO Director-General in his speech mentioned that the Award is given to SEAFDEC since "its achievement is an outstanding and practical hands-on contribution to the application of the Code."

After the adoption of the global Code of Conduct for Responsible Fisheries (CCRF) in October of 1995, SEAFDEC initiated a program on the Regionalization of the Code of Conduct for Responsible Fisheries (RCCRF) starting in 1998. The RCCRF took into consideration the Southeast Asian region's specific context, encompassing its culture, its fisheries structure, and the region's fishery ecosystems and came up with regional guidelines accommodating the specific regional concerns that the global CCRF might have failed to highlight and where the issues of particular importance to small-scale fisheries in Southeast Asia are amplified and elaborated on under the framework of the global CCRF.

The complete set of regional guidelines was adopted by the Southeast Asian countries and was endorsed and supported by the 27th Meeting of the ASEAN Ministers of Agriculture and Forestry in 2005, resulting in policy changes and renewed fisheries programs as well as modification of relevant legal fisheries provisions in each ASEAN member country. The impact of the implementation of the regional guidelines in the ASEAN region has been multiplied through human resource development and awareness building activities promoted by SEAFDEC resulting in positive change of attitudes among the stakeholders. This led to the advancement of responsible fisheries based on the CCRF framework in the Southeast Asian region by the governments and the private sector as well as by individuals in respective national and local levels.

Accompanied by Dr. Yasuhisa Kato, SEAFDEC Advisor and the Prime Mover of the RCCRF, SEAFDEC Secretary-General Dr. Siri Ekmaharaj received the Medal Award on behalf of the Southeast Asian Fisheries Development Center and the ASEAN Member Countries from the Director-General of FAO, Dr. Jacques Diouf in November 2007 in Rome,

Above: SEAFDEC Secretary-General, Dr. Siri Ekmaharaj with FAO Director-General Dr. Jacques Diouf. Below: Dr. Yasuhisa Kato, SEAFDEC Special Advisor, and Dr. Siri receiving the Award from Dr. Diouf.

Italy. In his acceptance speech, Dr. Siri emphasized that the "Medal Award gives SEAFDEC more inspiration and aspiration to intensify our efforts and to set higher sights in promoting responsible fisheries in the Southeast Asian region." While thanking FAO for the Award, he assured FAO that after winning the Medal Award, SEAFDEC will relentlessly continue to promote responsible fisheries in the Southeast Asian region more intensely, under the framework of the CCRF.

The Award came in the form of a commemorative metallic medal inscribed with "Southeast Asian Fisheries Development Center" as this biennium's recipient and a scroll describing the achievement of SEAFDEC as regards the promotion of the CCRF in the Southeast Asian region. The basic criteria for the Award included: (1) effort should be an outstanding practical hands-on contribution to the application of the CCRF; (2) output should be tangible; (3) activity should be a sustained effort; and (4) output should have the potential for a snowball or catalytic effect.

Steering the Small-Scale Fisheries of Southeast Asia towards Responsible Development

Signs are already evident that small-scale fisheries would be given more focus as FAO and the Regional Fisheries Bodies have already initiated the development of a global dedicated program on small-scale fisheries. This initiative is expected to also provide a momentum for the sustainable development of small-scale fisheries in Southeast Asia.

Yasuhisa Kato

Peoples in the Southeast Asian region have in principle depended on agriculture and its products for their economy. Recent developments however, have indicated that more and more people are already engaged in fishing but confining their activities in inland and inshore/brackish water areas avoiding risky operations when harvesting the fishery resources. To work in the ocean where people always stake high risk is considered a tough livelihood and is limited only to people with no other livelihood alternatives. Thus, the region's fisheries are concentrated in marine coastal waters.

Reports in 2004 (FAO, 2007) showed that the world's total fish production from marine and inland capture fisheries was 85.8 million mt. Indonesia and Thailand were counted among the world's top ten producers of marine and inland capture fishes, producing 4.8 million mt (5.6% of the world's total) and 2.8 million mt (3.3% of the world's total), respectively. Specifically for inland capture fisheries with the world's total production of 9.2 million mt, Myanmar, Indonesia and Cambodia were among the world's top ten producers, contributing 454,000 mt (4.9% of the world's total), 310,000 mt (3.4% of the world's total) and 250,000 mt (2.7% of the world's total), respectively.

With the world's total fish export amounting to 71,508 million USD, Thailand and Vietnam were among the top ten exporters of fish and fishery products in 2004 with their fish exports valued at 4,034 million USD (5.6% of the world's total) and 2,403 million USD (3.4% of the world's total), respectively. The above figures are very impressive in terms of the region's contribution to the world's total fish production and export from marine and inland capture fisheries. The efforts now being put up by the countries in Southeast Asia to improve production from marine and inland capture fisheries could result in the over-exploitation of the resources if such fisheries are not sustainably managed.

Issues and Concerns in Small-scale Fisheries

With the people's illusion that marine fishery resources can be infinitive, unregulated fishing operations mushroomed in the region's fishing grounds, particularly the trawl fishing grounds in the Gulf of Thailand and Java Seas. While large-scale fisheries have increasing difficulties to economically operate in most fishing grounds, small-scale fisheries (SSF) have survived providing a large number of livelihoods to the people living along the coastal areas. A large number

of fishing communities are formed not only in particular areas near fishing ports but scattered all along the coastlines. Small-scale fishermen operate in inshore waters (less than 3 mi from the shore) using small-scale fishing boats less than 5 gross tons. These fishing units normally mobilize the work forces of family members using small-scale but large variety of fishing gears to harvest the multi-species fishery resources. As their financial capabilities are normally weak, the fishers maintain their informal financial cooperation with middlemen where in most cases the middlemen deal with the marketing of the fish and fishery products. Such linkages form an exploitation pattern by the middlemen over the economically weak fishers, especially in the remote rural areas.

There are many concerns that impede the sustainability of the region's marine coastal fisheries. These include: (1) large number of fisherfolk; (2) poverty in the coastal areas; and (3) weak law enforcement system. These factors have contributed largely to the difficulties in establishing fisheries management systems in spite of the management tools that have been introduced and adopted. For the sustainability of the region's marine coastal fisheries which is generally small-scale, a strong and sound management system is ideally needed.

However, under the aforementioned circumstances, the SSF sub-sector continues to engage in irresponsible fishing as most fishers do not have other livelihood alternatives other than fishing. Other measures to improve the daily incomes of small-scale fishers are lacking in the rural fishing communities. Therefore, while the livelihoods of the SSF sub-sector are already deteriorating as the fishery resources have already been depleted by the unregulated fishing operations, fishermen still continue to engage in fishing unmindful of any management and conservation measures.

Diversification, a Value of Small-Scale Fisheries

Generally small-scale, the marine and inland capture fisheries in the Southeast Asian region use different types and sizes of boats and different types of fishing gears and methods catching a variety of target species. Such situation leads to the difficulty in defining exactly the region's SSF, even if a general requirement during discussions on the various issues related to SSF at the international/regional levels is to define SSF. This could be one of the many reasons why SSF was not given much focus in the global Code of Conduct for Responsible Fisheries.

When the regionalization of the "Code of Conduct for Responsible Fisheries" was discussed among the Southeast Asian countries to specifically focus on the region's SSF, the development of its definition was attempted a number of times but an agreed logical definition could not be reached. Thus, the Regional Guidelines for Responsible Fisheries in Southeast Asia: Responsible Fishing Operations (SEAFDEC, 2000) for example, instead cited tables showing the differences of the respective SSF in the Southeast Asian countries operating in certain fishing zones.

Even in the Southeast Asian countries, obtaining a standardized definition of SSF was practically difficult therefore developing a global definition can be more difficult and not practical. SSF has been developed in each locality or countries with their respective specific cultures, social and economic situations including the use of different types of boats, types of traditional fishing gears and methods, target species, post-harvest technologies. Another aspect of SSF that should be considered during any discussion is its cultural heritage that must have been extinguished due to the globalization and modernization process. Nonetheless, the different types of SSF can be recognized sometimes in terms of their values for tourism and culture. SSF is not only considered as a means to produce fish and fishery products, but the value of its existence also serves as a multi-functionality of the traditional ways of life in the coastal areas.

Collecting Information on SSF

The collection of reliable statistics on SSF for management purposes is a difficult task in most countries in the region considering its multi-species and multi-gear situation. The recorded high catch of miscellaneous fishes in many statistics books contributes to the problem of analyzing species composition constraining the process of assessing the potential species and technological interactions, two important parameters in stock assessment. Due to the difficulties in collecting the necessary information, an economic analysis of the region's SSF is hardly achieved at the national and regional levels.

Collection of information from large-scale/commercial fisheries that normally unload their catch at offloading facilities such as fishing ports could be easier. In the case of coastal fisheries which normally unload their catch at beaches or simple mooring points that are scattered along the coastlines, collection of data could be a gigantic task. It is even more difficult to collect data from inland fisheries, considering the fluctuating water surface due to seasonal floods in rivers and lakes. It is therefore a major challenge for government fisheries administrations to collect the

necessary information covering the coastal and inland fisheries in order to better understand SSF.

Thus, the difficult task of collecting data should be tackled first in order to achieve sustainable SSF development. However, when it comes to improvement of statistical data collection, most fisheries administrations still do not have the clear objective for collecting such statistics. While in the past their focus has always been on the collection of production data mainly for recording purposes, they have not been conditioned to the fact that for the development and improvement of fisheries management system, an appropriate statistical system to collect usable data should be carefully designed. Such design should include various factors such as the number of fishers and fishing boats, in order to understand the extent of over-capacity as basis for taking appropriate measures to mitigate the situation.

Poverty Alleviation for SSF

Resource deterioration and poverty are closely interlinked and generally observed as the paramount problem for the SSF sub-sector specifically in the Southeast Asian region. Such problem may not be effectively solved by fisheries sectoral approach but by widely seeking solution through the improvement of the general program on poverty alleviation and economic development at the national level. In the "Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region" adopted at the Ministerial Conference by fisheries related ministers in 2001 (SEAFDEC, 2001), no clause on poverty alleviation policy for the SSF was included. The Code of Conduct for Responsible Fisheries (FAO, 1995) which was used as basis for the formulation of the "Resolution and Plan of Action" also did not appropriately provide ways and means of mitigating poverty alleviation issues in order to achieve sustainable fisheries. This is in spite of the fact that poverty issue is an important element in ensuring sustainable fisheries, especially for the SSF which dominates in most developing countries.

Considering that in global fisheries more than 60% of the production comes from developing countries and that most fisheries in the developing countries can be categorized as SSF, poverty alleviation issue must be considered an important element in achieving global sustainable fisheries. In addition, if 90% of the 38 million global small-scale fishers are from the Asian region, again, sustainable fisheries in Asia must rely heavily on the sustainable livelihood of the SSF. The catch per unit effort by SSF may be much smaller than that of the large-scale commercial fisheries making the effect of SSF on fish production appears insignificant. However, even if the actual number of SSF fishers may not be precisely reported, it has been estimated that there might be about 38 million SSF fishers worldwide. If one fisher catches at least one ton per year, about 38 million tons of fish are annually caught by SSF, a figure which is no longer negligible.

The deterioration of the fisheries resource led the small-scale fishers to resort to destructive fisheries even illegal fishing operations, in order to improve their daily incomes even in a short-term basis. A global understanding on the poverty status of the SSF is therefore necessary in order to address the sustainability of small-scale fisheries. But this could be difficult to attain because some facts do not appropriately reflect the real economic situation of the small-scale fishers, which could be attributed more to government structural problems. Even a recent FAO study specified that the IMF's "Poverty Reduction Strategy Paper (PRSF)" prepared by many developing countries failed to appropriately accommodate fisheries poverty issues in their reports (Thorp, 2005).

The fisheries administrations in the government structure, which are normally small-sized had in the past focused their tasks mainly on technical improvement issues reflecting fisheries development requirements as in the case of most Southeast Asian countries. Fisheries management is considered by most fisheries administrations as a latest technically concerned issue and considering that SSF is a socially/economically weak sector, there is a general tendency that imposing government fisheries management interventions to SSF can be a heavy burden for many countries. Thus, the small-sized fisheries administrations are unable to provide fisheries management intervention leading to the absence of programs that would eventually give importance to SSF issues. Specifically, government agencies in most developing countries are not able to respond properly to the poverty issues of the SSF. In any way, poverty issues especially in the fisheries sector should be addressed somewhere in the government structure in order to achieve sustainable development of fisheries in the poorer communities of the developing countries.

Open-access vs. Limited-entry Policy

In the absence of a logical and legal definition of SSF, open-access to fishery resources continues to prevail in many developing countries including those in the Southeast Asian region. Although limited-entry has been tried in some countries, such regulation generally applies only to large-scale or industrial fisheries. Moreover, in the issuance of fishing licenses for example, a requirement to provide catch data to the fisheries administrations is imposed. The general non-observance of such requirement has constrained the efforts of fisheries administrations to monitor and assess the fish stocks, making it difficult to declare over-exploitation of certain stocks, in a way encouraging SSF to continue practicing the open-access system.

In many countries, even the development of gears and construction of fishing vessels are not well monitored contributing to the constraints in evaluating the fishing effort. The entry of large number of fishing boats in a relatively small area of fishing grounds is uncontrolled leading to heavy fishing pressure. Efforts should therefore be exerted to limit investments on boats, gears and also processing plant facilities. Although many countries in the region have already imposed moratorium on new coastal fishing licenses to reduce fishing effort, enforcement has always been lax especially because some law breaking activities happen in the oceans beyond the area of control of fisheries administrations. The cooperation among the various national law enforcement agencies is therefore necessary in order that sound fisheries management could be put in place.

Coastal Fisheries Management for SSF

Although the Code of Conduct for Responsible Fisheries (CCRF) encouraged the countries to establish appropriate fisheries management system in order to promote sustainable fisheries, a suitable direction and the methodologies on the management of SSF are not clearly provided. The CCRF gives more focus on high sea fisheries which could be due to the fact that SSF is generally understood as a socially/economically weaker fisheries sub-sector and that government management intervention on SSF including measures with authoritarian manner may not have been considered relevant by the developed as well as developing nations.

Furthermore, the CCRF included guidelines for fisheries management in general and the importance of community-based fisheries management in order to address issues related to small-scale fisheries has also been specified. Following the CCRF, several types of community-based fisheries management have been initiated in many countries of Southeast Asia. However, in most cases the implementation process failed as the country's customary laws may have not been considered in the formulation of new fisheries regulations. This leads to conflicts with the local populace who are bound to adopt such regulations. In addition, the management of marine capture fisheries in many countries in the region rests with their central governments, although in some instances the delegation of authority are already given to local government level, as in the case of the Philippines. With the adoption of the Philippine Fisheries Code in 1998, the authority to manage Philippine municipal waters has been delegated to the local government units. Such legal provision has however caused complications in terms of mobility of resources creating some problems for the local government units because they have not been prepared to undertake necessary actions including law enforcement.

Another factor that should be considered in developing sustainable fisheries management is to involve the fisherfolk as the important stakeholders of the fisheries sector. In order to empower the fisherfolk it is necessary that they form organizations that could represent them, considering the high illiteracy among the fishers. Through such organizations, fishers would be able to participate actively in any fisheries management activities including human capacity building. Considering also the various negative effects of unregulated SSF to the resources, government agencies should develop a management system that includes human capacity building with provisions for the promotion of alternative livelihoods for the fishers. The biggest challenge for any government agency therefore is to be able to identify appropriate management system for SSF.

There are special characteristics of the fisheries sector that need to be analyzed in order to facilitate the development of management system for SSF. Such characteristics are based on two issues, namely: (1) unclear ownership of the fisheries resources; and (2) government intervention in fisheries management.

Unclear ownership of the fisheries resources

Under the open access regime in fisheries, ownership of the resources could not be clarified due to the nature of the common resources and the migrating nature of the resources. Compared with other industries that normally invest assets on land such as in agriculture, fisheries operation tends to be irresponsible when utilizing such common resources. Legal instruments both international and national also failed to clarify the ownership of the fisheries resources by the users. It is therefore suggested that national general policy should be established modifying the direction of unclear ownership of the fisheries resource to: "providing a clear ownership" through the introduction of the rights-based fisheries.

The concept of rights-based fisheries for SSF could be different from those for commercial fisheries considering the nature of operation of SSF which is along the coastal areas by small units. A regional policy has been developed in 2001 through the "Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region" which specify as Resolution 5 the need to "Encourage effective management of fisheries through delegation of selected management functions to the local level" and as Resolution 6 to "Recognize the need to progressively replace "open access" to fisheries resources with "limited access regimes" through the introduction of rights-based fisheries which may also facilitate the management of fishing capacity and promote the use of responsible fishing gears and practices". Based on the aforementioned regional policy framework, the regional guidelines on "Co-management using group user rights for small scale fisheries in Southeast Asia" (SEAFDEC, 2006) was developed through a series of consultation processes with the SEAFDEC Member Countries considering the innovative concepts and approaches related to rights-based fisheries and co-management. The guidelines have since then been promoted by SEAFDEC for adoption in the ASEAN region.

Government intervention in fisheries management

Since fisheries resources are common resources, government intervention in fisheries management is necessary. In fact, no other industry requires government intervention in their management except fisheries and because of its nature the users become irresponsible in exploiting the resources. Most government fisheries administrations in the developing countries, established with their original objectives of technically assisting the industry when marine capture fisheries had the economic potentials in the early stage, fail to structurally adjust to their latest enormous mandate (starting in 1980s) of managing the fisheries as a whole. In addition, no mechanism was developed to manage SSF scattering along the coastal areas, which can be an enormous task if the current centrally structured fisheries administrations should accommodate such additional mandate. In order to mitigate such concern, it is therefore encouraged that governments promote an intervention "to delegate the management authorities to the resource users".

This particular Regional Guidelines also elaborate on the delegation of fisheries management authorities on coastal fisheries to local fisheries organizations in order to encourage the fisherfolk to take part in the management of the fishery resources. In consonance with such Regional Guidelines, SEAFDEC initiated a program on Integrated Coastal Resources Management with pilot locally-based coastal fisheries management projects in Thailand, Malaysia and Cambodia. The program generally aimed to establish sustainable coastal resources management at the local level; rehabilitate the coastal fishery resources; and alleviate poverty in coastal fishing communities. With the program having produced tangible impacts in the pilot project sites, SEAFDEC envisaged to impart the technologies including experiences and knowledge gained to the other SEAFDEC Member Countries.

Box 1: Regional Guidelines on Responsible Fisheries in Southeast Asia

- Responsible Fishing Operations supports the implementation of Article 8 (Fishing Operations) of the global CCRF in the ASEAN region
- Responsible Aquaculture which aims to mitigate the negative effects of aquaculture, provides supplementary guidance to Article 9 of the CCRF
- Responsible Fisheries Management supports the implementation of Article 7 (Fisheries Management) of the CCRF and provides suggestions for improving fisheries management with emphasis on human capacity enhancement for all levels of stakeholders involved in inland, coastal and marine fisheries
- Responsible Post-Harvest Practices and Trade serves as reference in identifying directions and priority actions for the implementation of Article 11 (Post-harvest Practices and Trade) of the CCRF
- Supplementary Guidelines substantiating the Regional Guidelines for Responsible Fisheries Management comprise: (1) Co-management Using Group User Rights for Small-scale Fisheries in Southeast Asia; (2) Fishery Statistics for Capture Fisheries in Southeast Asia; (3) Use of Indicators for Sustainable Development and Management of Capture Fisheries in Southeast Asia; and (4) Use of Fisheries Refugia for Capture Fisheries Management in Southeast Asia

Global Recognition on the Importance of SSF

Globalization of fisheries has been actively pursued since 1992 when the United Nations Conference on Environment and Development (UNCED) was organized due to the increasing international concerns over the global environment. FAO initiated the development of the CCRF in the same year as a response to the Cancun Conference as well as to Agenda 21 of UNCED. With decreased availability of development funding assistance corresponding to policy modifications of donor societies, FAO had to adopt a drastic policy change of its organizational mandate in the middle of the 90s with special focus on the promotion of globalization in concerned sectors including food security and sustainable development of primary industries. With such change of policy, FAO has therefore drastically shifted its focus from supporting developing countries to the promotion of globalization, a direction which was more accorded with much interest by developed nations.

The organization of the Committee on Fisheries (COFI) meetings has also been changed since the start of the formulation of the CCRF in 1992 to particularly focus on global agenda including various issues identified through the formulation process of the CCRF. Compared with small-scale fisheries that are country by country specific especially with respect to their socio-economic implications, high sea or off-shore fisheries mobilizing larger vessels which are basically designed by developed fishing nations vis-à-vis the various common problems in achieving sustainable fisheries, were given more focus during global discussions.

During the COFI session in 2007, the overwhelming clamor of developing countries dominated the agenda on SSF calling on FAO to support SSF through appropriate global programs as indicated in the COFI report paragraph 61: "The Committee considered different options to give greater prominence to SSF in its deliberations and FAO's Program of Work. The Committee also took note of the strong support by many Members to establish a dedicated COFI Sub-Committee and/or a specific program of work on SSF supported by dedicated extra-budgetary funding. Nevertheless, the Committee agreed that the issue of SSF was important and FAO should continue to work on the issue. Other Members highlighted the importance of integrating the concerns of SSF into all aspects of fisheries discussed at COFI and relevant subsidiary bodies."

Immediately after the COFI session, the 1st Regional Fisheries Bodies Secretariat Network Meeting was held in FAO, where the possible development of a program framework among the Regional Fisheries Bodies that are mainly working for the SSF was discussed reflecting the outcome of the COFI session. The Meeting agreed to provide and advice on the terms of reference and scope of work of such program, and to explore the possibility of developing an FAO program for SSF including the establishment of a dedicated website in order to develop such program.

Way Forward

As seen in the foregoing, focus on the issues on SSF were not appropriately provided earlier in any global program including the CCRF. This could be largely related to the fact that SSF are country and locally specific and thus, are not appropriately identified as global common issues to be promoted under any global initiative. In the case of the Southeast Asian region, a series of the Regional Guidelines on Responsible Fisheries in Southeast Asia have been developed by SEAFDEC since 1998 (**Box 1**), as outcomes of its Program on the Regionalization of the CCRF specifically focusing on particular situations of tropical SSF and supporting the implementation of the CCRF in the ASEAN region. The efforts of SEAFDEC in promoting the Regional Guidelines in the ASEAN region have been globally recognized when SEAFDEC became the most recent recipient of the prestigious Margarita Lizárraga Award for the biennium 2006-2007, given by FAO in November 2007.

SEAFDEC after receiving the Award commits itself to

continue working towards the sustainable development of SSF in the region under the framework of the CCRF. Thus, efforts have been sustained to collect information on the region's SSF in order to assess its status and hopefully come up with recommendations on the development of management systems for SSF.

The outcome of the initiatives of SEAFDEC is expected to contribute greatly to the efforts of FAO and the Regional Fisheries Bodies to develop a global dedicated program on SSF even if it has been considered very difficult to design a global dedicated program commonly useful for the diversified SSF in various regions in the world. As an attempt to initiate an assessment of the status of SSF, SEAFDEC has developed a dedicated website (http://www.rsn-ssf.net) to serve as an avenue for all those concerned with SSF particularly in the Southeast Asian region to exchange experiences and views on the sustainable development of SSF. In order to start the momentum for the development of a program focusing on SSF, SEAFDEC has preliminarily proposed the following activities as means of exchanging views with those who have wide experiences on SSF.

1. Global Monograph on Fishing Vessels for SSF

Considering the global concerns on the need to clearly define the SSF and the technical difficulty in reaching the regional definition experienced in Southeast Asian region, it is proposed to refrain from developing such definition exercise and to appreciate the diversification of SSF that are traditionally developed by region, country and each locality. Therefore, instead of tackling the global definition, it is proposed to develop a global monograph on fishing vessels used for SSF by exchanging information at the global level in order to globally recognize its cultural heritage. A standardized format on the information of fishing vessels is now being developed by SEAFDEC including the general principle of typical vessels and usage of vessels with a note that drawing or picture of the vessels would make very clear idea of the information provided.

2. Global Geographical Information of SSF

Despite of many discussions on the SSF, the fact that the very limited information on SSF is currently available is one of the major constraints to appropriately understand the SSF that is experienced in Southeast Asia. In seriously considering the sustainable development of SSF, this activity could be a starting point prior to the start of the program on SSF. SEAFDEC therefore proposed that a geographical information system be provided where global information on the number of fishers/fishing vessel either full time or part time basis can be plotted. The information can be an estimate at the national level but which can be gradually substantiated by the detailed information by provinces and/or district level of the participating countries. In addition, in order that cost effective data collection system can be analyzed, reports on success cases developed elsewhere in the world are also being collated.

3. Global Analysis on the Appropriate Methodologies on Rights-Based Fisheries for SSF

Through the global dedicated website, the cooperation to exchange experiences on rights-based fisheries that have shown certain success or potentials for future success is being called for. The global dedicated website is therefore meant to further create momentum on the issue in the long-term basis. The standardized format on the information of success cases on rights-based fisheries to be placed in the website is now being formulated by SEAFDEC.

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About the Author

Dr. Yasuhisa Kato is the Special Advisor of SEAFDEC based at the SEAFDEC Secretariat in Bangkok, Thailand. After working with FAO in Rome, he joined SEAFDEC in 1998 and has since then played vital role in the promotion of the CCRF in the Southeast Asian region through the development of the program on the Regionalization of the CCRF.

SEAFDEC through its Training Department has initiated the Integrated Coastal Resources Management project in Thailand, Malaysia and Cambodia under the auspices of the Japanese Trust Fund Program following the collaborative project operational mode. The community-based fishery resources management model with an integrated approach to encompass total community development in the SEAFDEC Member Countries served as the guiding principle in the implementation of the project. The lessons learned and experiences gained from the project in these three countries are being shared with the other ASEAN countries through the SEAFDEC training and information dissemination mechanism.

Fostering the Integrated Coastal Resources Management Approach in Southeast Asia

Sei Etoh

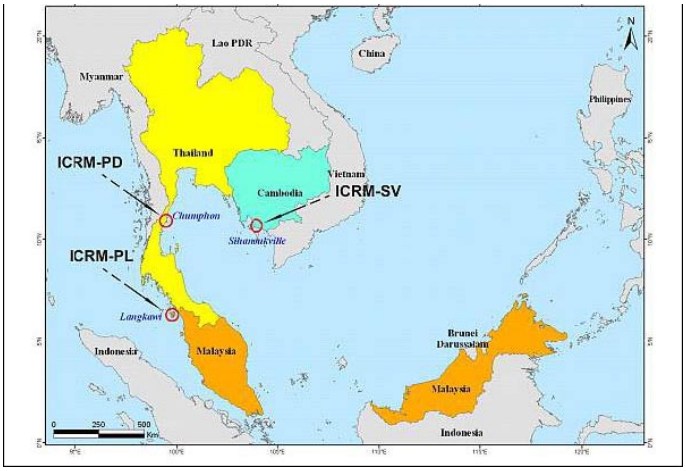
The deterioration of livelihood in coastal fishing communities resulting from the over-exploitation of fishery resources and degradation of the coastal environments has been a pivotal issue among fisheries policy makers in the Southeast Asian countries since the late 1990s. Discussions have therefore been centered on this theme in order to seek for applicable measures to improve and overcome the situation.

SEAFDEC has implemented the regionalization of the Code of Conduct for Responsible Fisheries (CCRF) and came up with regional guidelines on four major aspects, namely: responsible fishing operations, aquaculture development, fisheries post-harvest, and fisheries management. In another scenario, under the ASEAN-SEAFDEC Fisheries Consultative Group (FCG) collaborative mechanism, Thailand has been designated the ASEAN Lead Country and the SEAFDEC Training Department (TD) as the Lead Department for the implementation of FCG activities related to fisheries management. Thus, in accordance with the efforts of SEAFDEC to promote the adoption in the ASEAN region of the Regional Guidelines for Responsible Fisheries in Southeast Asia: Responsible Fisheries Management, TD collaborated with the Department of Fisheries (DOF) of Thailand for the implementation of an integrated coastal resource management pilot project in Thailand.

The Integrated Coastal Resources Management Project

Guided by the framework of the comprehensive development project of the Thai Royal Project Council and the community-based fishery resources management (CBRM) concept, the project on "Integrated Coastal Resources Management in Pathew District, Thailand (ICRM-PD)" was implemented in Pathew District, Chumphon Province. The successful implementation of the project in Thailand has been replicated in Malaysia and Cambodia, while the knowledge learned and experiences gained from the project implementation have been disseminated to the other ASEAN countries.

Following the CBRM concept and adopting it in the ASEAN setting, the Integrated Coastal Resources Management (ICRM) was implemented as pilot project by SEAFDEC/TD in Thailand, Malaysia, and Cambodia, from 2001 to 2008. The main objectives



of the ICRM project are to: (1) establish sustainable coastal resources management at the local level; (2) rehabilitate the coastal fishery resources; and (3) alleviate poverty in coastal fishing communities. Specifically under the ICRM approach, developing the capacity of local human resource will empower the local people in community development enabling them to manage the coastal resources and sustain development efforts, while the systematic voluntary participation by the local people in a local body will proactively strengthen community development and resource management. Moreover, the people's participation in creating job opportunities and in establishing local businesses will increase their source of accessible income thus, alleviating poverty and developing the economic base of the community.

Based on the CBRM concept, and in order to achieve the project adjectives, various activities are conducted under the ICRM project, such as monitoring surveys and data collection; adoption of the CBRM concept in the fishing communities; development of local business ventures; continuing HRD and improvement of fishing and fish handling technologies; and resource conservation and enhancement.

The implementation of the ICRM pilot projects starts with profiling of the project area through the conduct of baseline and monitoring surveys. This is aimed at monitoring the coastal fisheries dynamics as well as the socio-economic aspects of the target communities. Surveys are conducted to identify the needs and problems in concerned fishing communities, assess the environmental conditions of the fishing communities, identify employment opportunities for the local people, determine how the local people would utilize locally available resources, and identify the capacity building needs of the local people particularly in terms of research, training and extension. In the course of the project implementation, results of the surveys are presented to the stakeholders through local seminars and fishers' workshops to keep them abreast of the updated information.

Adoption of the CBRM approach is promoted for the sustainable development of the coastal resources. The approach to be adopted, which could differ from place to place based on the outcomes of the baseline surveys, would then depend on the socio-economic level, the surroundings and the resources available in the communities. Encouraging the local people to participate in community development activities would increase their awareness of the benefits that can be derived from their involvement in the CBRM activities, and more particularly, inculcating in them that their maximized voluntary participation in the protection and conservation of the resources would improve their livelihoods.

Establishment of a community organization by the local people is another core activity promoted by the ICRM project, as the organization would be responsible in managing the project activities when the assistance of the agencies involved in the initial and organizational phase of the collaborative project is phased out. It is in this aspect that HRD is necessary to prepare the capacity of the local people in the management of the resources. Training the local people including the local authorities and community representatives in the management of the project activities will provide them a sense of ownership of the project enhancing collective efforts in striving for the sustainability of the activities and ensuring continued protection and conservation of the resources. HRD, which should be a continuing process in the fishing communities, comes not only in the form of training courses, workshops, seminars or study tours but also in the form of continuous hands-on practice in the everyday operations of the project.

Why do we need an integrated approach?

In the orthodox or conventional project execution, single oriented approach was usually applied. However, lessons were learned through field activities that various components are compounded in the development needs of the targeted societies so that a multi-faceted approach would produce more effective and tangible outputs. Sometimes, these factors are essentially inter-linked with each other, such as the case of the CBRM approach. Actions on awareness building on CBRM have been conducted predominantly through human resource development (HRD) activities like training, fishers' workshop, etc. However, if a society lives below the subsistence level, no one would care about the sustainable management of fishery resources for the future because their main focus is today and the immediate tomorrow. They can not afford to think of matters in the future. In the Southeast Asian region, although some fishing communities have already attained certain degrees of development over this level still there are some that live beyond. In such cases, an integrated approach combined with total community development aiming at poverty alleviation is considered more effective and practical.

Box 1. Timeframe of the ICRM Project Implementation

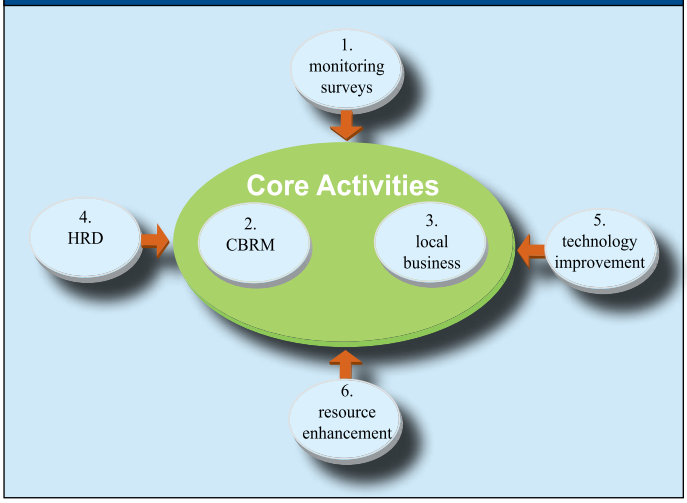
No.	Component	2001	2002	2003	2004	2005	2006	2007	2008
1	Thailand (ICRM-PD)	←						→	
2	Malaysia (ICRM-PL)			←					→
3	Cambodia (ICRM-SV)					←			→

Another approach being promoted under the ICRM project is the development of alternative livelihoods by the local people that would provide them additional and accessible sources of income. In the pilot project sites, the local people have been encouraged to identify alternative livelihoods and other business ventures that they are capable of implementing using locally available resources. With this approach, the local people also instigate cooperation among the members of the community specifically as regards the development of certain products including development of marketing channels for their products to ensure the sustainability of the income-producing activities in the community.

An equally very important aspect of ICRM is the rehabilitation and enhancement of the coastal resources. Under this approach, the local people are involved in resource enhancement activities to make them aware of responsible coastal resources management, and specifically on the need to protect the environment and conserve the natural resources of their communities. Promoting responsible and sustainable fishing and fish handling methods is also essential for the sustainability of the CBRM efforts in the fishing communities. This will help the local fishers understand the need to adopt responsible fishing operations as these would assure them of stable fish harvests and increased incomes.

Following the aforementioned approaches, the SEAFDEC ICRM project was initially implemented in Pathew District, Chumphon Province of Thailand (ICRM-PD) from 2001 to 2006. Then later this was replicated in Pulau Langkawi, Malaysia (ICRM-PL) from 2003 to 2007 and in Sihanoukville, Cambodia (ICRM-SV) from 2005 to 2008. The timeframe of the project implementation in the aforementioned countries is shown in **Box 1**, while the systematic implementation structure of the project activities is shown in **Box 2**.

Box 2. Systematic structure of the ICRM project activity implementation



The ICRM Project in Pathew District, Chumphon Province, Thailand

The ICRM project in Pathew District, Chumphon Province, Thailand (ICRM-PD) has served as an avenue whereby the visions of the Government of Thailand are put into action specifically its goal of poverty alleviation and sustainable development. The involvement of the local people in the project management increased their awareness of the importance of protecting the environment and managing the coastal resources that they have been exploiting. This has also encouraged the local people to take mitigating actions on the damages that are being done to the resources thereby decreasing any further damages on such resources. The project has also provided the local people certain means of alternative livelihood that helped them sustain their daily needs while optimizing the use of the resources that are available in their communities.

Towards the termination of the project, the final project evaluation was conducted by an outsourced consultant, the results of which was published and disseminated (**Box 3**) in the region. In addition, the Regional Seminar in Integrated Coastal Fisheries Management in Southeast Asia which aimed to disseminate the impacts and outcomes of the project in the Southeast Asian region, was conducted on 10–12 July 2007 in Chumphon, Thailand.

The most significant outcomes of ICRM-PD include: (1) the successful establishment by the local people of a locally-based coastal resource management body, the Pakklong Fisheries Group (PFG); (2) improvement in the people's production and living conditions; (3) enhancement of the local people's and organization's capability in resource management and community development; and (4) incorporation of the practices and lessons learned from the implementation of the project in the DOF policies on coastal resource management.

Box 3. Summary of the final project evaluation of the ICRM-PD project

"The activities of this project are well planned that every aspect of the issues are resolved. Baseline survey is assessed as very good because it provides all the important details needed to identify and prioritize the issues in the area. The CBRM activities are very significant in the understanding and learning process of the local people regarding the protection and conservation of the environment and the coastal resources. The local businesses of the villagers are very significant as well because these provided them with alternative and/or additional sources of income to sustain their daily needs. More importantly, the dissemination of information materials to local people is a great way to keep them updated with and informed about recent developments and enables them to identify ways where they can participate and extend help. Lastly, the resource enhancement activities are very important in engaging the interest and participation of the local people rather than just giving them theoretical knowledge which is difficult for them to visualize and understand" (SEAFDEC, 2007).

Role of the Pakklong Fisheries Group

While the involvement of SEAFDEC in the project was phased out at the end of 2006, and the involvement of DOF and other local agencies tapering down from 2006 onwards, the Pakklong Fisheries Group (PFG) took over the responsibilities of the project starting in 2007. It was therefore very necessary to prepare the PFG and enhance its capacity for the management of the project during the phasing out process. The extent of involvement and initiatives of the cooperating agencies as exemplified in the ICRM-PD, are shown in **Fig. 1**.

Since the PFG has been officially registered with the provincial administrative office, it has been endowed with a legal entity as a fishermen's cooperative with 105 members. After the termination of the involvement of SEAFDEC in the ICRM-PD project in 2006, the PCG has implemented a number of activities under the general guidance of the DOF Thailand. More specifically, the Local Enforcement Unit was established within the PFG to pursue the local MCS activities in the demarcated zone of the project area.

Adoption of the CBRM Concept by Local Fishers

In line with the basic concept of the CBRM, the demarcated zone to regulate exploitation of fishery resources in the ICRM-PD project area was publicly proclaimed in October 2002 after its approval by the Thai Cabinet. Within the demarcated zone, various fisheries management plans have therefore been implemented. The demarcation, which includes a zone for aquaculture and zone for fishing vessels sheltering during inclement weather conditions, was proclaimed after it has been agreed upon by the relevant stakeholders through a consensus. Another zone was also proclaimed for the fishing ground of swimming crab as agreed by the crab trap fishers' group and the crab gill-netters' group.

Since swimming crab is a very important species harvested in the project area, the fishers became concerned about the dwindling crab catches and reduced sizes occurring year by year. To address the problem, a crab bank scheme was initiated in 2002, where under the scheme gravid crabs are deposited in cages until they spawn. Another measure taken was the introduction in 2003 of enlarged mesh size crab trap from 1.2 in to 2.5 in to reduce the incidence of catching juvenile crabs in crab trap fishing operations. Such mitigations have resulted in improved total catch and increased size of crabs caught.

In the ICRM-PD demarcated zone for aquaculture, an experiment of the culture of Babylonia shells was carried out to test the practical and commercial application of the culture technology. Other culture strategies have also been tried such as cage culture using natural and artificial feeds of sea bass and swimming crab. However, the results although quite feasible gave marginal or low economic returns due to the inadequate background of the local fishers on such culture technologies.

In an attempt to promote resource enhancement in the demarcated fishing zone of the ICRM-PD, artificial reefs (ARs) were installed by DOF Thailand in 2004, while Fish Enhancement Devices (FEDs) developed by TD were also installed in 2005 and 2006. However, the FEDs were removed or relocated by trawlers that continue to encroach in the project area, making it imperative to install the FEDs again in deeper areas adjacent to the existing ARs to protect them from being removed by trawler operators.

While the project also aimed to educate the children of the local fishers, fish releasing ceremonies were initiated in 2006. In the ICRM-PD project area, about 7.3 million post-larvae of shrimps, 154,000 sea bass fingerlings, 44,000

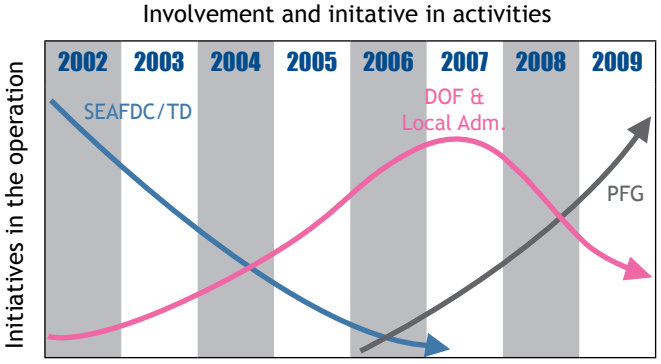


Fig. 1. Extent of the involvement and initiatives of the cooperating agencies in ICRM-PD

juvenile and mature size swimming crabs, and 300 adult mud crabs have been released by the school children.

As one of the major activities in the adoption of the CBRM, mangrove rehabilitation was also organized by the PFG in coordination with the Ao.Bo.To. and the nearby schools. In 2006, more than 2,000 mangrove seedlings have been planted in the demarcated zone. In addition, tree planting was also carried out along the District's roadside by the village groups.

In addition to the Royal Project Council, the DOF and the Department of Marine and Coastal Resources (DMCR) of Thailand, other local agencies and offices have also been involved in the implementation of the ICRM-PD project. These included the Chumphon Marine Development Center (CMDEC) Fisheries Technological Development Division, Chumphon Fisheries Provincial Office Enforcement Unit and Aquaculture Center, Chumphon Provincial Administration Office including the Pathew District Administration Office and the Cooperative Promotion Office, the Chumphon Marine and Coastal Resources Research Center, and the Pakklong Sub-district Administrative Organization (Ao. Bo.To).

The Integrated Coastal Resources Management in Pulau Langkawi, Malaysia

Since the ICRM-PD project had produced tangible impacts as acknowledged by the SEAFDEC Member Countries during the 4th ASEAN-SEAFDEC FCG Meeting in March 2002, SEAFDEC decided to impart the technologies including the experience and knowledge gained, to the other Member Countries. In this regard, Pulau Langkawi, as offered by Malaysia became a pilot site for the implementation of a similar approach on a cost-sharing basis. TD subsequently set up the project on "Integrated Coastal Resources Management in Pulau Langkawi, Malaysia (ICRM-PL)" in 2003.

The activities of the ICRM project in Pulau Langkawi, Malaysia (ICRM-PL) was however, temporarily put on hold during the wake of the December 2004 Tsunami which had also affected the project area. Most fishing boats and fishing gears were destroyed or lost during the calamity including the fish landing facilities which was also completely destroyed. The project activities have been restored later in 2005 after some rehabilitation works. Since then, the project activities have been pursued by the Department of Fisheries (DOF) Malaysia after the involvement of SEAFDEC had been phased out in 2007.

The Fishery Resources Management Community

Unlike in the ICRM-PD, a core fishing group known as the Fishermen's Economic Group or KEN, which was reorganized later into the Fishery Resources Management Community (KPSP), already existed in the project area and was responsible for the implementation of the CBRM concept under the ICRM-PL. Under the general guidance of the DOF Malaysia, the KPSP eventually took over the operations of the project area independently when the involvement of TD was terminated. At the course of the implementation of the ICRM-PL project, the fishermen expressed their views on many occasions that the volume of fish landing had evidently increased since the previous years. They attributed such increase to the effectiveness of the local enforcement activity organized by the KPSP following the CBRM concept.

One of the major accomplishments of the ICRM-PL was the drafting by the local people of the Fishery Resources Management Plan (FRMP) which was submitted to the Department of Fisheries Malaysia for approval. Although a long time and tenacious efforts were spent in building up a consensus for the demarcation of the coastal fishing zone among the stakeholders including the fishers from neighboring fishing villages and industrial fisheries, after a

series of repeated meetings, the draft FRMP was formulated, and the demarcated zone for the CBRM in the ICRM-PL project area was considered.

After the 2004 Tsunami and in an effort to rehabilitate the livelihood of the local fishers in the project area, a mechanical workshop was built under the auspices of the Japanese Grassroots Tsunami Fund (JGRTF). The workshop facility, which is being managed by the KPSP, has been leased out to one of its members for marine engine repair and maintenance. In addition, the Local Enforcement Unit (LEU) established mainly to coordinate the MCS functions in the project area, has succeeded in acquiring a patrol boat from the local government authorities in early 2008. The LEU has since then been strengthening their MCS functions, and their presence has led to reduced encroachment by illegal fishing boats in the project area. The KPSP has been endowed with competent leadership with fairly high morale for self-development and self-management. This is a great asset for the adoption of the CBRM concept and community development.

The successful outcome of the crab bank scheme carried out by the ICRM-PD project has challenged the KEN after their study tour to Chumphon, Thailand in April 2005. The experience they gained led to the organization of a Crab Bank sub-group under the ICRM-PL, and in order to upgrade the lessons they learned, a training course on crab bank scheme operation was conducted on site.

The women's group called the Women's Economic Group or KEW was also organized in the ICRM-PL project area. Production of seasoned/dried anchovy called "ikan bilis" was started by the KEW following the technique which they learned during their study tour to Chumphon Province, Thailand. A cottage scale processing yard was constructed for the group under the auspices of DOF Malaysia. Since the KEW has further diversified their production line to another major fish-based product called "maruku", the need to construct a new large-scale processing yard was considered.

Making funds available under the JGRTF, the new processing plant was constructed that could accommodate the production of value-added fish products by the KEW. Moreover, a user-friendly bookkeeping and accounting system was introduced to the KEW through repeated trainings in order to maintain transparency in business transaction within the group.

Results of the resource surveys have shown that the fishing ground of the ICRM-PL project area is relatively low in fishery resources because of its flat bottom. This situation demanded the need for the installation of ARs and FADs. Thus, a number of ARs and FADs have been installed by the LKIM and DOF Malaysia, while SEAFDEC also installed FEDs in several sites but unfortunately these were removed by trawlers that have been encroaching in the demarcated coastal fishing zone. Further strengthening of the local enforcement group is therefore vital before installing another set of FEDs in the project area.

Mangrove reforestation is also one of the activities under the ICRM-PL. In December 2006, more than 1500 mangrove saplings have been planted in front of the bay of the project area in Kuala Teriang by volunteer fishers from the KEN in collaboration with the Drainage and Irrigation Department (JPS) of Pulau Langkawi. In nearby Kuala Melaka, a volunteer fisherman who has learned about the CBRM concept and more specifically the importance of mangrove reforestation planted 2100 mangrove seedlings in March 2007. The promotion of coastal resource conservation and enhancement under the ICRM-PL has primarily motivated a series of movements on mangrove reforestation in Kuala Teriang and nearby villages.

The ICRM-PL has availed of the assistance from agencies in the Kedah State and the Central Government by promoting a harmonized working coordination among local and national components including the Lembaga Kamajuan Ikan (LKIM) or the Fisheries Development Authority of Malaysia, Kedah State Fisheries Office, District Fisheries Office in Langkawi, the Langkawi Development Authority (LADA), Fish Technology Institute of Malaysia (IPM) in Terengganu, Fisheries Research Institute (FRI) in Penang, Fishermen Association in Langkawi, Village Level Security Committee (JKKK) of Kuala Teriang, etc.

The Integrated Coastal Resources Management in Sihanoukville, Cambodia

In the wake of the implementation of the pilot ICRM projects in Thailand and Malaysia, a third ICRM project was initiated in Cambodia (ICRM-SV) in collaboration with its Fisheries Administration (FiA) in 2005, taking into account the geographical advantage and the prioritized need of a CBRM approach in the country. The project site is located in Prey Nup II in Sihanoukville comprising four major villages, where a core body to implement the CBRM concept has been established prior to the implementation of the project. Cambodia is the only country in Southeast Asia where a fishery-resources co-management regime is legitimately established. The Royal Decree on Establishment of Community Fisheries and the Sub-Decree on Community Fisheries Management were promulgated in May 2005 and June 2005, respectively.

Foreseeing termination of the involvement of SEAFDEC in the project operation towards the end of 2008, a step-by-step phasing out process of the project operation has been promoted to ensure a smooth handing-over of the project to the FiA. However, TD will continue to take part in the project activities in its capacity as observer and to provide technical inputs in the project activities specifically during the evaluation of the impacts and outcomes of the project which will be undertaken by an outsourced consultant.

Among the major achievements of the ICRM-SV is the preparation by the local people of the Community Fisheries Area Management Plan (CFAMP). Developed by the local fishers group, the CFAMP and other related documents such as Internal Law (I/L), By-Laws (B/L) and the Community Fisheries Zoning Map (CFZM) were endorsed by the local administration offices and sent to the Governor of Sihanoukville together with the Community Fishing Area Agreement (CFAA) for approval. The approved Guidelines for the Community Fisheries govern the implementation of the CBRM concept in Sihanoukville, Cambodia under the ICRM-SV project.

The Community Fisheries in Prey Nup II

After the organization of the Community Fisheries (CF) in 2002, the Local Enforcement Unit (LEU) was established with voluntary participation of the CF members and has been in-charge of patrolling the coastal area for illegal fishing operations. In 2005, the FiA provided patrol boats with engine to the LEU and with support of the ICRM-SV project, the voluntary activity of patrolling the project area by the LEU has led to increased number of arrests on various charges such as use of illegal fishing gear, sea turtles hunting, mangrove felling, charcoal production, and harvesting juveniles of shells and crabs. Cases of encroachment in the project area by illegal fishers and violations against fisheries regulations have been evidently reduced.

Within the CBRM concept, the ICRM-SV will also establish fish refugia in the project operational area. The preliminary survey conducted to investigate the social and practical impacts of fish refugia recommended the establishment of two fish refugia, one for blood cockle and another for sea grass in Khos Angkor and Khos Krous, respectively. The establishment of fish refugia under the ICRM-SV would support a regional movement being promoted in Southeast Asia where several fish refugias would be established in the coastal zones from Cambodia to Vietnam.

Immediately after the commencement of the project, the women's groups were organized under the framework of the Community Fisheries Prey Nup II. As one of the feasible lucrative cottage-scale business ventures, mushroom production was proposed to be carried out by the women's groups. The result of a feasibility study conducted by the project staff indicated that mushroom culture could be implemented considering the practical and economic points of view including its marketing aspects. With technical assistance from a former JICA-funded project, a training course in production of oyster mushroom following the Japanese mushroom production technology was conducted under the ICRM-SV at the Vocational Training Center in Battambang with 20 participants.

After returning to their villages, the women's groups carried out the construction of necessary facilities and equipment by themselves. Production of mushrooms has been successfully continued and it has been turned perfectly into a commercialized venture. It is commendable that all groups have put the venture on commercial basis within the period of one year. Upon the initiation of the mushroom production, an intensive training course in simple bookkeeping and accounting system was conducted for all members of the mushroom production group to promote transparency in their transactions.

In a related development, the ICRM-SV project negotiated with the Embassy of Japan (EOJ) in Phnom Penh, Cambodia for possible collaboration in the project's mud crab fattening activity. As a result, EOJ agreed to provide funds for the construction of the culture ponds and for the procurement of necessary equipment for mud crab fattening through the Japanese Grassroots Fund. The Mud Crab Culture Group was formed and the first trial of mud crab fattening was conducted from February to May 2007. However, due to inadequate background on mud crab culture techniques, the result gave negative net profits. Considering the lessons learned from the first experiment, which failed because of very high temperature and salinity in the culture area, the second experiment commenced in November 2007 after deepening the culture ponds to attain lower temperature. In the second trial, a JICA expert stationed in Phnom Penh has been tapped to provide technical supervision. So far, the progress has indicated some promising results. Commercial mud crab fattening will be started as soon as convincing outcome from the experimental production is attained. Another experiment in fish culture of sea bass was also conducted in parallel with mud-crab fattening.

During the group study tour to Siem Reap Province in August 2007 participated by 10 leading fishermen from Prey Nup II Community Fisheries, a Sangkat (Commune) chief, a fisheries officer from Sihnoukville Municipality, national and TD project staff, to observe other approaches to local business development within the community fisheries, the group observed that the application of eco-tourism venture in Prey Nup II may not be very successful

since only few tourists visit the area unlike in the Siem Reap Province. In their visit to the Community Fisheries Chi Kraeng, known for organic agriculture production and small-scale aquaculture, the group considered such approach as applicable for the ICRM-SV provided that a competent extension worker would be made available to assist them in the technical aspects of an integrated agri-aqua operation.

In the project implementation, the ICRM-SV project has availed of the support and assistance from various concerned local authorities like the District (Khan) Office in Prey Nup, Sub-District (Sangkat) Office in Prey Nup II and the Fisheries Office of Sihanoukville Municipality which have been involved in the regular project operations. In addition, the Fisheries Administration of Cambodia has been in charge of the over-all administration of the project while the Embassy of Japan in Phnom Penh has extended financial support to the project through the Japanese Grassroots Fund.

Way Forward

As described above, the ICRM project has been implemented in three different countries as pilot projects to demonstrate the practical applicability of the community-based resource management (CBRM) concept that has been developed and successfully adopted in other countries such as Japan, in local fishing communities in Southeast Asia. While the project intends to apply the process of decentralization where ownership of the resources is handed over to the local authorities, it was also envisaged to snowball a model for the dissemination of the CBRM concept in the region. Specifically, the rationale of implementing such concept lies in testing the applicability of such an approach in each country and anticipating further expansion or dissemination of the modus operandi to other areas in the country by responsible authorities.

The ICRM project was also envisioned to come up with significant results that would lead to rehabilitated and enhanced coastal resources as well as poverty alleviation in the coastal fishing communities. Specifically, the total embodiment of the CBRM approach not only by the resource users but also by all stakeholders would ensure that the resources are being utilized in a sustainable way. With all stakeholders participating in the decision-making process of the coastal resource management, they share the responsibility with concerned authorities in the management and in the elimination of destructive and illegal fishing operations thus, conserving the resources.

Under the CBRM concept, one of the major objectives is to deliver improvements in terms of increased fish production and subsequently the living conditions of the stakeholders. Solutions to overfishing and over-capitalization will definitely lead to improved socio-economic conditions of the resource users and their families. With the fishers' involvement in the organized groups, they become capable of pursuing resource management and community development activities on their own initiative. The improved institutional capacity of the local organizations and local governments would lead to strengthened cooperation among the people and the institutions involved in self-help economic and social activities.

In case of ICRM-PD, it has been taken over by DOF of Thailand under the financial auspices of the Royal Project Council after the termination of the involvement of SEAFDEC in December 2006. Although the ICRM-PD has attained significant results, TD within its capacity still needs to continue providing assistance in terms of guidance and provision of certain technologies as necessary, and in supporting the project in terms of follow-up activities.

For the ICRM-PL project, the DOF Malaysia has continued implementing the activities and formulated the Project Implementation Committee within the DOF to manage the project. Similarly for the ICRM-SV, management of the project activities has been pursued by the Fisheries Administration of Cambodia. In the case of the ICRM-PL and ICRM-SV, assessment of the impacts and outcomes on the communities still needs to be carried out. Therefore, the assistance of TD would still be necessary in terms of monitoring and evaluating the outputs of these projects. TD would therefore continue its support to the project within a limited budget in the form of follow-up actions to ensure that all attempts exerted in the pilot stage would be pursued further with their practical applications.

From the initial outcomes of the project implemented in Thailand, Malaysia and Cambodia, the lead government authorities have been provided with models for the possible dissemination of the CBRM concept to other areas in their respective countries. Government authorities are therefore encouraged to take the opportunity of implementing similar projects for the sustainable management of their coastal areas. As envisaged during the planning of the project, the knowledge and experience gained through the project operations would also be disseminated to the other SEAFDEC Member Countries when and where possible, through the technology transfer mechanism being promoted by SEAFDEC.

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Sustainable Tilapia Farming: A Challenge to Rural Development

J.D. Toledo, B.O. Acosta, M.R.R. Eguia, R.V. Eguia and D. C. Israel

The availability of improved Nile tilapia strains is a major factor that has opened up new avenues for renewed growth in the tilapia industry especially in the rural sector. This was hailed as a positive development in the tilapia industry because it promised opportunities for improvement of the rural economy. Although this article discussed the development of tilapia aquaculture in the Philippines, other countries can learn from this experience specifically in addressing challenges related to rural development.

In the Philippines, tilapia is the second most important fish species that is farmed to improve food security and alleviate poverty. Tilapia farming in the country dates back to the early 1950s with the introduction of the Mozambique tilapia. However, it was not until 1970s when Nile tilapia (*Oreochromis niloticus*) from Thailand and Israel was introduced into the country did the tilapia farming industry start to develop. With the introduction of better growing species, tilapia farming operations expanded and this resulted in the improvement of the country's overall tilapia production. Along with this however, was a problem which later emerged due to deterioration of genetic quality of farmed tilapia stocks. Since farmers experienced decline in tilapia production, this prompted the national, regional and international organizations to develop new improved strains of the species and associated technologies.

Status of Tilapia Aquaculture in the Philippines

Tilapia and its importance to rural development

Combating poverty, particularly in the rural sector is a serious challenge of the Philippine Government. World Bank reported that in 2003, about 11% of Filipinos lived on less than 1.00 USD/day and 40% on less than 2.00 USD/day (Anon., 2006). The problem is most acute and widespread in the country's rural areas where the incidence of poverty is 54% compared to 25% in urban areas (United Nations, 2005).

To address the above challenge, the country's Medium Term Philippine Development Plan (MTPDP) for 2004-2010 has identified the aquaculture sub-sector as one of those that will support the country's drive towards combating poverty and promoting the development of the rural economy (ADB, 2005). In line with this, the Philippine Department of Agriculture has formulated measures to achieve the desired growth in the agriculture and fisheries sectors. One of these is through farming of high priority species that include the Nile tilapia – a commodity which ranked as the second most important food fish for the country's mass domestic consumption (BFAR, 2006).

History and production trends

Tilapia farming in the Philippines began in 1950s and mainly utilized low-input backyard ponds using the Mozambique tilapia (*Oreochromis mossambicus*). This species which was introduced in the Philippines in 1950s became unpopular because of its slow growth, small size at harvest, precocious breeding and other undesirable traits. In view of these characteristics, production of tilapias during 1960s was relatively low and ranged from 70-390 mt (**Fig. 1**).

In 1970s, a faster growing tilapia species (Nile tilapia) was introduced in the country and this generated a renewed interest in tilapia farming. Subsequent to this was the development and successful application of culture technologies which resulted in widespread farming operations of tilapia (particularly in many provinces in Luzon, Philippines) and a substantial growth in the country's overall production. Tilapia aquaculture production rose from 70-390 mt in 1960s to 9,436–15,434 mt in 1980s. However, growth in overall tilapia production was nearly

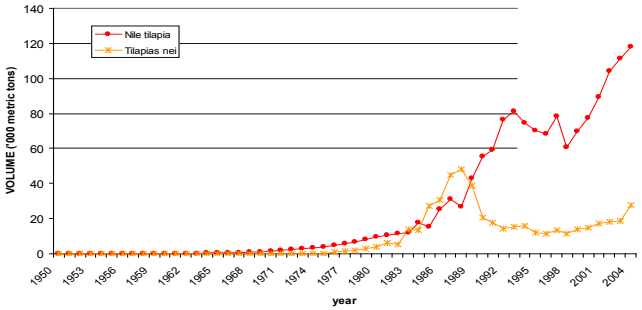

Fig. 1.Total tilapia aquaculture production (volume = '000 mt) in the Philippines, 1950-2004 (FAO, 2006)

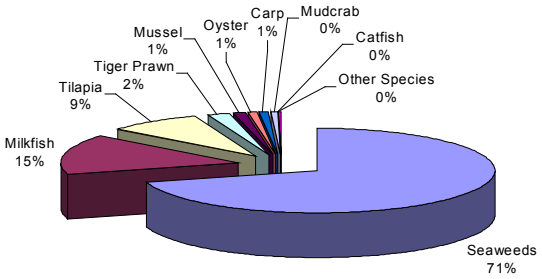

Fig. 2. Aquaculture production in the Philippines by species in 2005 (BAS, 2007)

disrupted during the 1980s when farmers experienced a decline in farm productivity due to deteriorating quality of Nile tilapia stocks.

To avert this problem and to address the emerging need of the tilapia industry, public sector R&D (by government owned, regional and international institutions) pursued the genetic improvement of locally farmed stocks through selective breeding (and other genetic improvement technologies) from 1986 to the present.

Dissemination of genetically improved Nile tilapia strains began in early 1990s and this signaled the start of a flourishing tilapia industry in the country. **Fig. 1** shows the year 1998-2004 as the period when there was accelerated growth in tilapia aquaculture and production reached its peak. With this 'boost' in production, the country emerged as the 3rd largest tilapia producer globally in 2004 (FAO, 2006). The total tilapia production during this period was 145,869 mt, a substantial change from the production during the early years of tilapia industry when it was constrained by poor genetic quality of stocks and limited supply of tilapia seeds.

In 2005, tilapia aquaculture production increased further (163,000 mt) and contributed 9.5% to Philippine aquaculture production (BAS, 2007). In terms of production by commodity (**Fig. 2**), tilapia ranked third after seaweeds (1,895,800 mt) and milkfish (289,200 mt).

Tilapia Aquaculture in the Philippines at Current Level

Availability of a wide variety of improved tilapia strains

The development of improved tilapia strains is a major factor that spurred the growth of the tilapia industry in the Philippines. At present, the following improved strains of tilapia are available for farmers to choose from: GIFT (genetically improved farmed tilapia); GST (Genomar Supreme Tilapia), FaST (FAC Selected strain of tilapia), GET-EXCEL, GMT (genetically male tilapia), and the SEAFDEC selected strain.

With the availability of improved strains and the opportunities for a better profitable margin, more farmers were encouraged to get into tilapia farming operations - both hatchery and grow-out. ADB (2005) reported that farmed tilapia production increased during the period 1981-2001 and this was mainly due to improved quality of seeds available in the market.

Commitment of public sector institutions in tilapia R&D

One of the strengths of tilapia aquaculture in the country is the presence of public R&D institutions that are continuously committed to addressing the needs of the tilapia industry. It is a known fact that the culture technologies and improved strains which are commercially available in the country are products of strong research and development cooperation among the public sector R&D institutions in the Philippines (national program institutions, regional and international research organizations based in the Philippines). The chronology of the initiatives which led to the development of improved tilapia strains (**Box 1**) indicated that for over 20 years, many institutions have been actively involved in tilapia R&D and the Philippine tilapia industry has benefited immensely from the efforts made by these institutions/ organizations (Abella, 2006).

Multi-stakeholder involvement in tilapia farming

The country's tilapia industry comprises various 'players' whose roles are crucial in the attainment of the goal as specified in the country's Master Plan for the Tilapia Industry (i.e., to increase farmed tilapia production from 122,000 mt in 2002 to 250,000 mt in 2010). Recognizing

Cage culture of tilapia in Laguna de Bay, Philippines

the need for concerted efforts in order to meet this target, representatives from various stakeholder groups in the tilapia industry (R&D institutions, private sector, policy making bodies, feed manufacturers/suppliers, exporters, and farmers) have joined hands and established in 2003 the Philippine Tilapia, Inc. This group provides a forum for stakeholders in the tilapia industry to work together through advocacy, promotion of tilapia consumption and implementation of the tilapia industry development plan (ADB, 2005).

Strong participation of the private sector

Another notable development which has provided a big boost in tilapia farming from the latter part of 1990s to the present is the strong participation of the private sector, particularly in seed production. About 90% of the country's current tilapia seed production of about 1 billion annually comes from private sources. Private sector farmers also work hand in hand with the public sector in seed distribution, extension, financing for farm operations and setting directions for the tilapia sector (ADB, 2005). Private seed and feed suppliers advise farmers on appropriate practices as well as in improving their products and these have helped contribute to the rapid growth of the tilapia sector (Engle, 2006).

Government's support in tilapia industry

In view of the tremendous potential that tilapia could bring in terms of addressing the country's need to enhance food security, the Philippine Government strongly supports and promotes the nationwide farming of tilapia, particularly the genetically improved strain. In line with this initiative, the aquaculture sector through the Bureau of Fisheries and Aquatic Resources (BFAR) provides a greater focus on developing an improved strain (GET-EXCEL) by making this and associated culture techniques available to farmers in all regions in the Philippines, through its dissemination programs.

Strong market demand

The continuous improvement of tilapias by the public sector breeding institutions in terms of quality (e.g., improvement in size, carcass quality, etc.) has contributed to the increased demand for tilapia products in the market. Survey studies found that tilapia has become an important fish in the diet of Filipinos with the decline in the consumption of milkfish, round scad (known locally as "galunggong") and other native freshwater fishes (Edwards, 2006). Traditionally, milkfish has been the most popular and widely farmed fish in the country while round scad has also been considered as the most popular yet affordable marine fish for the poor.

Way Forward

Challenges Facing Tilapia Farming

It is projected that by 2010, the Philippine population will reach 95 million and the expected demand for fish is 2.9 million mt. In view of this, the government is faced with a greater challenge of addressing the issue of food security, particularly in terms of sustainability of fish supply. By 2025, the demand for fish in the Philippines is expected to increase to about 4.2 million mt while the estimated population is 134.9 million (Anon., 2005).

Sustaining the growth of the country's tilapia production

The country's tilapia industry master plan has targeted a 72% increase in tilapia yield by 2010. To achieve this, it is imperative that growth of tilapia production is sustained and its full potential is harnessed in order to bring benefits to the rural economy and to the country in general. The Department of Agriculture (2002) reported that with the availability of improved tilapia breeds, existing science-based, farm-verified technologies for tilapia seed production and culture, this projected increase could be attained and sustained especially if the most urgent concerns (**Box 2**) are addressed.

Bringing benefits of tilapia farming to the rural community

Apart from sustaining the country's growth of tilapia production, another big challenge for the Philippine Government is to ensure that the rural community will benefit from the tilapia industry. **Box 3** provides suggestions on how tilapia aquaculture technology could reach the rural poor communities.

Research Needs

R&D institutions have been major contributors to the country's ability to address the pressing issues affecting tilapia aquaculture and as such have been credited as primary forces that motivate growth in the tilapia industry. It is crucial that these institutions remain vigilant to developments of the country's tilapia aquaculture sector and through research, training and extension continue to address the issues affecting the industry. Apart from this, complementary policy interventions must be identified and implemented to ensure that outputs of tilapia R&D will positively impact the rural economy and the country in general.

In view of the dynamics of tilapia industry in the Philippines, there is a need for both public and private sectors to continue working together in order to address the major challenges and attain the target indicated in the tilapia development plan. A number of research areas/initiatives have been proposed (**Box 4**) to improve tilapia production in the Philippines. These include researches in genetics, improved production techniques, marketing and credit, improved extension methodology, institutional and social aspects, nutrition and environmental impact.

Conclusion

Much is expected from the Philippine tilapia aquaculture particularly in terms of addressing the country's food security agenda. There is no doubt that tilapia aquaculture will continue to grow in terms of production. However, the main challenge of the tilapia industry is how this growth can be sustained in the long-term and in a manner that all sectors of the society particularly the rural community will benefit from.

In view of the high expectation from the tilapia aquaculture sector, the industry is now in a phase when cooperation and stronger partnerships among all the 'players' involved is crucial. The Philippine experience has revealed that if one is to address the needs of the tilapia industry, the programs of both the public and private sectors (particularly breeding and dissemination) must be in synergy or constantly in tune with the needs, requirements and capacities of the industry (Rodriguez, 2002). Parallel efforts must also be made in the formulation of policy programs and institutional mechanisms to ensure that benefits from tilapia farming and advancements in tilapia technologies will reach the small-scale farmers and the rural community.

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Box 1: Tilapia Genetic Improvement Programs in the Philippines

A decade and a half after its introduction into the Philippines, growth of Nile tilapia stocks have deteriorated as a consequence of genetic founder and bottleneck effects (Pullin and Capili, 1988), gene introgression from the less desirable Mozambique tilapia (Macaranas et al, 1986) and inbreeding (Eknath et al, 1993). Because the tilapia genetic resources used for aquaculture then had been poorly managed, genetic improvement of these limited locally farmed stocks was pursued through selective breeding programs implemented in the Philippines from 1986 up to the present.

1989: Quantitative genetics research on the Nile tilapia began when SEAFDEC and Central Luzon State University (CLSU) became members of the Aquaculture Genetics Network in Asia (AGNA), a regional network supported by IDRC of Canada. Composed of five Asian countries (China, India, Indonesia, Philippines and Thailand), AGNA was organized (in coordination with IDRC consultants from Dalhousie University) to produce: (1) a group of aquaculture geneticists in Asia; (2) a set of proven techniques for aquaculture genetic data analysis and stock improvement; and (3) genetically improved strains of fish for use in Asia (Timm, 1988; Doyle and Newkirk, 1988). With support from IDRC, SEAFDEC and CLSU worked on tilapia genetic improvement by developing statistical and experimental procedures for genetic strain evaluation, producing a salinity-tolerant strain of *O. niloticus* through hybrization with *O mossambicus* (Villegas, 1990; Basiao 2001) and enhancing growth in tilapia strains using within-family selection (Abella et al, 1990; Bolivar and Newkirk, 2002). Apart from developing standard strain evaluation procedures at SEAFDEC, a fast-growing improved stock known as FaST or FAC-selected (Freshwater Aquaculture Center-selected) tilapia was developed by CLSU researchers. First introduced in 1993, this improved breed was produced through within-family selection involving locally adapted Asian Nile tilapia strains bred through a rotational mating scheme. The genetic gain per generation for this selected stock was estimated at 12% (Bolivar and Newkirk, 2002).

1998: Two other internationally funded tilapia genetic improvement programs were implemented in the Philippines. In collaboration with BFAR, FAC-CLSU, UP-MSI and Institute for Aquaculture Research or AKVAFORSK of Norway, the World Fish Center (formerly ICLARM), conducted the Genetic Improvement of Farmed Tilapias (GIFT) project from 1988 to 1997 (Eknath et al, 1993, Bentsen et al, 1998; Gupta et al, 2001). Funded by UNDP and ADB, the GIFT project developed the GIFT Tilapia, a synthetic strain produced by crossing the best families from four Asian and four African founder stocks. Growth of this synthetic breed was enhanced through several generations of combined selection. In 1999, the GIFT Foundation inked an exclusive contract with GenoMar ASA, a private multinational company, for the commercial rights and brand name of the GIFT Super Tilapia and subsequent improved breeds that may be derived from their joint research activities (Gjoen, 2001). Presently, GenoMar has produced the GST or GenoMar Supreme Tilapia developed from the 9th generation GIFT (or G9) and further improved with the use of a DNA-based technology. Launched in late 2002, GST is believed to have 40% higher genetic gain (in terms of growth) compared to G9 (Gjoen, 2001).

Simultaneous with the GIFT program, the GMIT (Genetic Manipulation of Improved Tilapia) or YY supermale project was implemented to principally address the problems of early sexual maturation, stunting and overpopulation in tilapia culture and also to generally solve genetic deterioration in farmed tilapia strains (Mair et al, 1997). Conventional methods such as sex reversal, manual segregation of male tilapias from females and interspecific hybridization have been tried to solve overpopulation and stunting in farmed tilapias. This British ODA funded project allowed the University of Wales in Swansea, UK, FAC-CLSU and BFAR-NFFTRC to develop YY male tilapia genotypes (novel male tilapias with two male "YY" sex chromosomes instead of "XY" for normal males) through generations of feminization and progeny testing. When crossed with normal females, these YY supermales are able to sire a mean progeny sex ratio of 95% male (Mair et al, 1997). Growth of GMT tilapia was shown to be 30-50% higher than mixed sex tilapia.

1999: SEAFDEC developed its own growth-enhanced strain through a simple farm-based size-specific mass selection on previously size-graded stock. SEAFDEC-selected tilapia (SST) was developed from a domesticated Thai Nile tilapia stock called Chitralada. Response to selection after one generation of size-specific mass selection was noted at 3.2 %.

2002: BFAR introduced an improved tilapia stock known as "BFAR GET 2002 EXCEL Tilapia". Dir. Melchor Tayamen has coined the name "GET-EXCEL" which is an acronym for Genetically Enhanced Tilapia EXcellent strain that has comparable advantage over other tilapia strains for Entrepreneurial Livelihood projects in support of aquaculture for rural development". This stock was produced by combining strain crosses and adopting within family selection using the following strains: G8 or eighth generation GIFT, 13th generation FAST, Egypt and Kenya strains. The GET-EXCEL strain is purported to be 38% better in terms of growth and yield than unimproved tilapia stocks (Tayamen, 2005). This stock has been distributed by BFAR's NFFTC, central hatcheries, provincial/municipal hatcheries and/or certified/registered private hatcheries to Philippine fishfarmers through the DA-initiated project entitled "Nationwide Dissemination of GET EXCEL Tilapia" (Tayamen, 2005). The project aimed to transfer genetically improved tilapia and updated rearing technologies to resource-poor farmers through -- breeding and production, training, evaluation, and seedstock distribution cum technology demonstration.

At present, several tilapia stocks have been developed for specific environments. To promote tilapia culture in brackishwater ponds, rivers and estuaries, PCAMRD, BFAR-NIFTDC and CIRAD of France, developed a highly saline tolerant tilapia referred to as Molobicus or SaltUNO. The selection scheme involved the repeated backcrossing of progenies of *O. niloticus* and the hypersaline *Oreochromis mossambicus* (Camacho et al, 2001; Rosario et al, 2005). Another salt-tolerant hybrid, BEST or Brackishwater Enhanced Selected Tilapia was developed by BFAR-NFFTRC and FAC-CLSU. This strain was developed using three euryhaline tilapia species (*O. mossambicus*, *O. aureus* and *O. spilurus*) and three genetically improved Nile tilapia strains (GIFT, YY-supermale or GMT and FAST) as founder stocks. Meanwhile, to encourage tilapia culture in the Philippine uplands or in rural areas with relatively cooler climates, a cold-tolerant Nile tilapia stock named COLD was developed by BFAR-NFFTRC using the G8 or eighth generation GIFT and the FAST. Experimental trials have been made, however the stocks have yet to be tested commercially. The availability of these genetically enhanced stocks somehow contributed to improved yields particularly in the tilapia-producing provinces (Bulacan, Pampanga and Tarlac) near the Tilapia Science Center, Nueva Ecija, Philippines where most of these strains were developed and disseminated. Moreover, with the promotion and adoption of technologies for rearing salt-tolerant Nile tilapia strains, tilapia production from marine/brackishwater culture areas (especially in Visayas and Mindanao), have also gradually improved.

Box 2: Most Urgent Concerns in Philippine Tilapia Production

1. maintenance of genetic integrity in improved tilapia stocks
2. sustainable production of genetically improved seedstock
3. formulation of guidelines on how to manage this new diversity (new genetically differentiated aquaculture stocks) in the context of resource conservation for aquaculture and fisheries
4. adoption of regulatory mechanisms for controlling environmental degradation caused by aquaculture activities in lakes, rivers and reservoirs where tilapia are farmed
5. creation of a coordinating body composed of public and private sector representatives that will manage and ensure the growth of the tilapia industry (the Philippine Tilapia, Inc. was established in 2003 to address this need), the challenge now is how to sustain the interest of this coordinating body

Box 3: Challenges in Expanding Tilapia Aquaculture Technology to Rural Poor Communities

Making the improved strains and associated culture technologies available to rural sector

Enhancing the access of fish farmers (especially those from rural areas, operating in small-scale and with limited resources) to improved strains of tilapia. At present, most small-scale farmers are dependent on distribution centers for improved tilapia seeds that are expensive and not sufficient to meet market demands (Basiao et al, 2005). Other farmers get their tilapia seeds from suppliers who also act as middlemen and which, in many cases, result in higher price thus making the tilapia seeds not affordable to farmers with limited capital. Another factor which influences the accessibility of farmers is the geographical location. While the present government program undertakes widespread dissemination in all regions/ provinces for GET-EXCEL, dissemination of most improved strains in the country is still largely confined in Luzon, where most tilapia producers are located (Acosta et al, 2006).

Improving the access of rural sector farmers to financial resources

One of the serious constraints of farmers in getting into tilapia farming is their lack of capital/financial resources (Sevilleja, 2006). Since the capital required to operate tilapia farming is beyond the reach of ordinary small-scale farmers, the need to formulate mechanism for financial assistance so that farmers with limited resources especially those from the rural sector can get into tilapia farming (hatchery or grow-out), is crucial. ADB (2005) reported that the Philippine Government has low interest credit and financing programs for the fisheries sector; although some programs are being channeled through commercial private and government controlled financial institutions. However, only very few farmers avail of these programs due to stringent requirements during loan application.

Enhancing the efficiency of extension system

The Philippine tilapia industry in general is still hampered by the lack of effective extension system. Despite the present efforts being made by the government in extending technical assistance to farmers, there is in general poor coordination among research institutions, local government units and farmers which negatively affects the growth of the industry. While the private sector's involvement in the dissemination of tilapia seeds can help provide the link that will facilitate the transfer of improved strain and associated culture techniques to end-users, there are issues that influence the efficiency and effectivity in their delivery to small-scale farmers (Acosta, et al 2006; Sevilleja, 2006). It is therefore necessary to strengthen institutional linkages/stakeholder involvement for the efficiency of extension services and for the greater impact of tilapia farming on rural development.

Harnessing the full commercialization of tilapia

One of the weaknesses of the Philippine tilapia industry is the lack of strategy and supportive environment for full commercialization of tilapia, particularly in the export market. While the country performs well in terms of tilapia production (i.e., it consistently ranks as one of the top 10 producing countries globally), there are factors that impede the full commercialization of this commodity. The problem is more evident for small-scale producers in the rural community who, usually, do not have the capacity to comply with the regulations and standards set by the export market. Dey and Ahmed (2005) indicated that food safety regulations, hazard analysis and critical control point (HACCP) processes, and technical barriers to trade have introduced high costs that tend to exclude the small producers and processors from the export supply chain. Apart from these, there is also lack of market information and increased competition in sales which, in many cases, result in lesser income or profit on the part of the producers. Dey and Paraguas (2001) reported that although tilapia is one of the cheapest fish in the Philippines, the price of tilapia in the Philippines is still higher than it is in international markets, making it difficult for the Filipinos to export the fish. In the Philippines, the high cost of commercial feed contributes largely to increase in the overall production cost of tilapia. Hence, another challenge is to bring down the production cost to enable the farmers to compete in the export market.

Box 4: Suggested Research Areas/Initiatives for the Improvement of Tilapia Production

Genetics
Maintenance of the genetic integrity of improved tilapia stocks
Preliminary efforts have already been done, which should be continued, in monitoring the genetic integrity of farmed tilapia stocks (including genetically improved strains) using molecular markers and other methods.

Managing new genetically differentiated tilapia stocks
This can be done through marker-aided broodstock management schemes. With genetic marker data, appropriate broodstock management and genetic improvement methods can be formulated to protect the diversity of existing tilapia genetic resources. Thus whenever possible, DNA markers should be integrated in schemes that promote the sustainable management of farmed tilapias. Sustainable management can be achieved by both developing tilapia lines that can be utilized immediately for farming and maintaining highly genetic variable populations as valuable genetic resources for future use (Romana-Eguia and Taniguchi, 2006).

Improved Production Techniques
A study that will assess risk aspects of small-scale tilapia culture compared to other production-oriented investments should be initiated. How should risk in tilapia culture in particular and aquaculture in general, be minimized so that the poor can truly practice it?

Improved Marketing and Credit
Investigation on the impact of middlemen such as concessionaires on the profitability and economic viability of small-scale tilapia farming should be conducted. This includes searching for ways to decrease the marketing chain for tilapia ventures in order to increase the profitability from culture. In addition, a study of micro-credit and other mechanisms means of addressing the credit and finance-related aspects of small-scale tilapia culture should be pursued.

Intensify Extension
Investigation on how the country's tilapia extension aspect can be improved should be made, specifically on why extension services are weak despite government/institutions' efforts. What are the factors that impede the effective delivery of extension services to farmers, particularly in the rural sector? Is there a need for improved extension scheme? Examples of current institutional efforts on this aspect are the on-site training by BFAR, SEAFDEC/AQD, and other local agencies; publication of tilapia extension manuals written in English and translated into the vernacular.

Institutional and Social Aspects
The role of cooperatives and farmer organizations in small-scale tilapia culture should be explored. This includes a study on how small-scale tilapia growers and the poorest of the poor must be effectively organized to optimize access to production inputs, technology, credit, market opportunities (local and export) and other important components of a tilapia-based business operation. Socio-economic survey of the potential specific areas and groups of poor population who can specifically be targeted for the development of tilapia culture should be conducted. This would also include the development of untapped areas for small-scale tilapia aquaculture (e.g, lakes and other water bodies in Mindanao).

Nutrition
There is at present aggressive promotion by feed companies for the utilization of artificial feeds in fish farms especially in many provinces in Luzon. Commercial tilapia feeds are costly. Hence, less and less farmers are able to use this for their farm operations. One important area of study is to look for ways of lowering the production cost (includes the cost of inputs such as tilapia feed).

Environmental Impact
Tilapia aquaculture is a dynamic and aggressive sector in the country. With the rapid expansion and intensification of tilapia farming, it is crucial that an assessment is made on the environmental impacts of tilapia aquaculture and based on the findings, to identify and implement the necessary policy interventions.

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MAXIMIZING OPPORTUNITIES IN SEAWEEDS FARMING

Maximo A. Ricohermoso, Pedro B. Bueno and Virgilia T. Sulit

This small-scale seaweeds culture project, explained in detail in this article has been initially put forward as an option to provide investment opportunity for the Overseas Filipino Workers as they do their share in boosting the Philippine economy. Nevertheless, the project could also serve as reference for fisherfolk in the ASEAN region wanting to invest in seaweeds farming.

The international food additives (e.g., carrageenan, agar, hydrocolloids, WSPs, etc.) market is valued at USD 3.0 billion a year. To fisherfolk in Southeast Asia, this presents a huge opportunity to cross the poverty line. The question is what kind of immediate opportunity and how can they exploit it? One product the region has a competitive edge in is carrageenan, a colloid from red seaweeds. The expanding uses of seaweeds extract, particularly the carrageenan, either as hydrocolloids or natural water soluble polymers (WSP) in human and pet food industries and in pharmaceuticals, have spurred the development of seaweed culture technology. The rising cost of production and failure to find low-priced suitable substitutes has driven demands and opened opportunities for developing nations in the ASEAN and some African countries to develop their seaweeds industry.

The Nature and Uses of Carageenan

Carrageenan (**Box 1**) is almost synonymous to agar, which is also derived from another red algae, the *Gracilaria* spp. Agar is used more in microbiology for bacteria culture because of its gel-like substance, which is most suitable for testing bacterial presence. Agar is also used in medical preparations as it tends to produce a laxative effect. Like carrageenan (**Box 2**), agar is also used in the preparation of ice cream, soup, jelly or even in brewing wine or beer. Carrageenan and agar are classified as hydrocolloids.

Hydrocolloids (**Box 3**) are hydrophilic polymers of vegetable, animal, microbial or synthetic origin that are naturally present or added to control the functional properties of aqueous foodstuff (i.e. it keeps them firm or consistent). The most important properties of hydrocolloids are viscosity (including thickening and gelling) and water binding. Other significant properties include emulsion stabilization, prevention of ice recrystallization as well as having organoleptic properties (refers to any sensory properties of a product, involving taste, color, odor and feel).

Alternative Livelihood for Poor Fishers and Coastal Dwellers

Red seaweeds can be farmed in most coastal areas in the Southeast Asian region. It is necessary that the coastal people have the capacity to farm the seaweed in a sustainable,

Box 1. Carrageenan

Carrageenan is a polysaccharide prepared by alkaline extraction from red seaweeds (*Rhodophycae*), mostly of genus *Chondrus, Eucheuma, Gigartina and Iridaea*. Its name is believed to have been derived from a type of seaweed that is abundant along a coastline near the village of Carragheen in Ireland, where the red seaweed is also known as the Irish moss. Some marine biologists and seafarers also called this the "sea lettuce". Gelatinous extracts of carrageen seaweed have been used as food additives for hundreds of years. Chinese culinary experts used to make sweets from the seaweeds, served after a meal for special guests. There are five species of seaweeds commonly found in the ASEAN region. These are: *Eucheuma* spp. (usually eaten fresh or processed for export), *Caulerpa* sp. (exported fresh or in salted form), *Sargassum* sp. (as meal additive in animal feeds), *Gelidiella* sp. and *Gracilaria* sp. (both exported dried and/or alkali-tested). *Eucheuma* spp., which has a number of uses and is most in demand in the export market, can be farmed in most of the region's coastal areas.

Carrageenans are large and highly flexible molecules having curl-forming helical structures and the ability to form a variety of different gels at room temperature. It is for this reason that they are widely used in the food and other industries as thickening and stabilizing agents. There are three main commercial classes of carrageenan: Kappa – strong, rigid gels; Iota – soft gels; and Lambda – form gels when mixed with proteins rather than water, to thicken dairy products.

Box 2. Some of the many uses of carageenan

- Gelatinous extracts as food additives and home made sweets
- Preparation of ice cream, soup, jelly and in food processing
- Brewing and wine making
- Control of functional properties of aqueous foodstuff (i.e. it keeps them firm or consistent)
- Emulsion stabilization, prevention of ice recrystallization
- Pharmaceuticals and personal care
- Manufacture of adhesives, pulp and paper, textiles, paints and coatings
- Water treatment in the oilfield, and in biodegradable products

Box 3. Hydrocolloids and WSPs

Foodstuffs require a number of different hydrocolloids; the most important of which are Agar, Alginate, Arabinoxylan, Carrageenan, Carboxymethylcellulose, Cellulose, Curdlan, Gelatin, Gellan, ß-Glucan, Guar gum, Gum arabic, Locust bean gum, Pectin, Starch, and Xanthan gum. In 2001, the total world market for hydrocolloids was USD 3,000 M which comprised 25% starches (USD 675 M), 21% gelatin (USD 635 M), 16% carrageenan (USD 435 M), and others 40% (USD 1205 M). "Others" include pectin, xanthan, gum arabic, agar, locust bean gum, etc.

There is also an emerging industry for water soluble polymers (WSPs), which has a USD 3.0 B market. WSPs are used in almost all food processing industries and in pharmaceuticals and personal care, adhesives, pulp and paper, textiles, paints and coatings, water treatment, in the oilfield, and in biodegradable products. There are two main types of WSPs, natural and synthetic.

Natural WSPs are derived from vegetable and animal sources. The vegetable sources include sap of trees (e.g. arabic gum), seed extract (e.g. guar carouba gum), algus extracts (e.g. agar-agar, alginates), plant extracts (e.g. pectins), starches (e.g. potato starch, corn starch), and dextrin (e.g. xanthan gum). Animal sources include milk (e.g. casein) and fishes, skin, bones (e.g. gelatin glues). Synthetic WSPs include vegetable derivatives such as starch derivatives (e.g. acetate), cellulose derivatives (e.g. sodium carboxymethykcellulose or CMC), guar derivatives (e.g. HP guar). Another class of synthetic WSPs are the petrochemical derivatives, such as acrylics.

environmentally friendly manner and are provided the incentives in doing so. This condition requires rational approaches to the development of the industry that includes farming, processing, marketing and trade.

In the Philippines, where seaweed contributes the majority of the total mariculture production, the government considers it as a major commodity, along with milkfish and tilapia that has the potential to generate food and income for poorer groups. The Philippines is the largest producer of

Table 1. Seaweeds resources as raw materials for carrageenan (as of 2002)

Country	Production (mt)	% of total resource
Philippines	80,000	50%
Indonesia	60,000	38%
Malaysia	10,000	6%
African and other countries	10,000	6%
TOTAL	**160,000**	**100%**

cultivated seaweeds; it used to provide 80% of the world's raw materials supply but this dipped to 50% in 2002 with lower production and Indonesia increasing its output (Table 1). The Philippine Government's support to the country's seaweed industry is exemplified in **Box 4**.

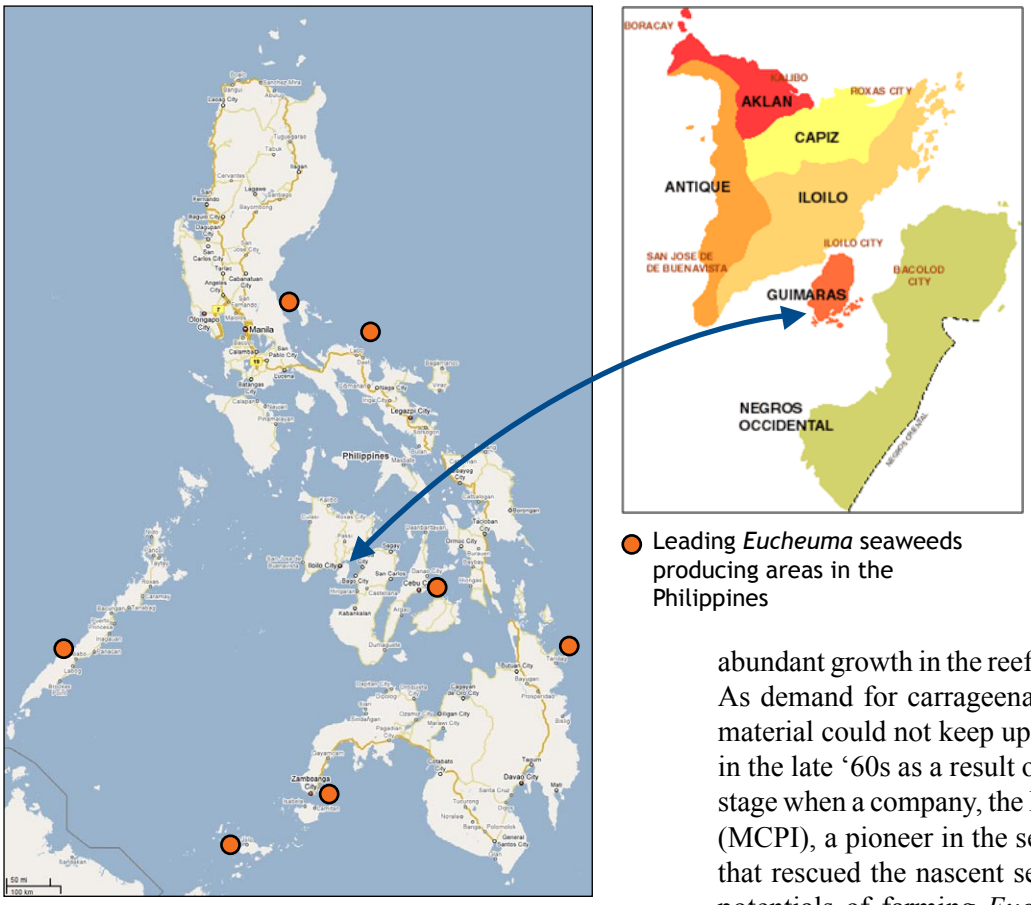
Commercial Seaweed Resources

The seaweeds industry emerged in the Philippines in the mid 1960s. It now forms the backbone of the world's USD 500 M carrageenan industry. It has contributed an average of USD 150 M annually to the Philippine economy giving 60% direct benefits to the seaweed farmers by providing direct livelihoods to over 150,000 families. The five leading Eucheuma seaweeds producing areas in the Philippines are: (1) Tawi-Tawi, Sulu, Basilan, and Zamboanga in southern

Box 4. Seaweed (*Eucheuma*) culture in Guimaras Island, Western Visayas, Philippines

In 2001, the local government unit of San Lorenzo (Guimaras Island in central Philippines) requested BFAR Region 6 to introduce seaweed farming in Nadulao Island as a potential alternative to blast fishing in the area. A fishers' organization with 17 members was formed to be responsible for four seaweed farms. Under the GMA (Ginintuang Masaganang Ani) program, the Seaweed Culture Project was created in collaboration with the Office of the Provincial Agriculturist and the Office of the Municipal Agriculturist. The site was expanded to include three other villages in San Lorenzo and 19 additional villages in the municipalities of Buena Vista, Nueva Valencia and Sibunag (all in Guimaras Island).

In April 2004, a Provincial Seaweed Development Council (PSDC) Technical Working Group (TWG) was formed comprising representatives from government and commercial institutions. The PSDC-TWG then created the Seaweed Growers and Traders Association (SGTA) which now sells their products directly to Cebu-based processors and exporters. As of 2006, there were 16.65 ha under cultivation and benefiting 162 farmers. In 2005, the beneficiaries sold over 6.0 mt of fresh and 22.0 mt of dry seaweeds valued at USD 14,977.00. Farmers said the supplementary income from seaweeds culture has kept them away from their illegal fishing activities and enabled them to send their children to school (G. Gonzales, 2006).



Leading *Eucheuma* seaweeds producing areas in the Philippines

Map of the Philippines showing Guimaras Island and leading Eucheuma producing areas

Philippines; (2) Palawan and Polilio (Quezon Province) in Luzon area; (3) Danajon Reef in the Visayas area; (4) Masbate, Camarines Norte and Sorsogon in Bicol region; and (5) Surigao Provinces in northern Mindanao. The major carrageenan processing companies are located in the Visayas (6) and in Mindanao (6).

The first commercial seaweed farming in the country was introduced in Sulu Sea in the 1960s. But it was not until 1966 that the Philippines received recognition of its seaweed processing as an industry. Initially, no attempt was made to cultivate the *Eucheuma* spp. in the country, with its abundant growth in the reefs, fishers simply collected them. As demand for carrageenan increased, the supply of raw material could not keep up and in fact dropped alarmingly in the late '60s as a result of over-harvesting. It was at this stage when a company, the Marine Colloid Philippines, Inc. (MCPI), a pioneer in the seaweed industry, did something that rescued the nascent seaweeds trade – it explored the potentials of farming *Eucheuma*. Their successful trials led to the establishment and promotion of seaweed farms and a processing industry specializing in the manufacture of the Philippine natural grade (PNG) carrageenan, which is mainly from the Eucheuma species. Since then the Philippine seaweeds industry has been dependent on the *Eucheuma* spp. as the major source of raw material for carrageenan. In early 2000, dried harvest of the seaweed was about 110,000 mt but this decreased to about 90,000 mt in 2002.

In order to sustain production of *Eucheuma* spp., new farming areas were developed throughout the country with technical assistance from MCPI and other exporting and processing firms. Thus far, the Philippines is now considered one of the world's few countries, which has successfully

Table 2. World supply of *E. cottonii*, MC=38-42% (in '000 mt)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005*
Philippines	110.0	108.0	93.0	116.0	114.0	99.0	90.0	90.0	96.0	108.0
Indonesia	27.0	27.0	25.0	28.0	30.0	31.0	35.0	47.0	55.0	66.0
Malaysia	3.6	4.2	4.8	5.4	6.0	4.9	1.8	3.0	3.0	3.0
Indochina	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	3.4	6.0
African and other countries	1.2	1.2	0.8	0.7	2.0	2.4	1.5	2.2	2.4	2.4
World Total	141.8	140.4	123.6	150.1	152.0	137.3	128.3	142.6	159.3	185.4

Source: 6th Mindanao Seaweed Congress, May 2006
* estimate

cultivated *Eucheuma* spp. on a commercial scale. The most important species for raw materials for carrageenan are: *Eucheuma cottonii* and *E. spinosum*.

Other seaweed species with commercial importance are: *Gracilaria* sp. and *Gelidiella* sp., which are still mostly harvested from natural growth; and *Caulerpa lentillefera*, which are cultured in ponds and lagoons. Of the estimated annual *Eucheuma* spp. harvest of 130,000 mt, 95% is *E. cottonii* (producing kappa carrageenan) and only 5% *E. spinosum* (iota carrageenan). The estimated annual market demand according to the Seaweed Industry Association of the Philippines (SIAP) is 165,000 mt by domestic processors and another 240,000 mt by processors in other countries, and this demand is expected to increase by at least of 10%. By 2005, the world's supply of *E. cottonii* had reached 185,400 mt (**Table 2**).

Concerns

The Philippine Government recently designated the National Fisheries Research and Development Institute (NFRDI) to include in its medium-term plan the National Seaweeds Development Program. The program aims to generate baseline information of the country's seaweed resources as a basis for formulating management policies for the utilization and conservation of the resource and to address industry constraints. Major issues include the alleged environmental effects of seaweed farming; the strong competition among players in the industry; and the soaring market prices, which is keeping foreign buyers away.

In the 60s, the seaweeds bonanza in the Philippines triggered a "gold rush" to the coralline areas of Sulu Sea. The fisherfolk in the areas built houses on stilts in the middle of the seaweed farms. In two decades, farmer colonies grew exponentially and the reefs became polluted. This contributed to the degradation of the reef environment and the quality of the crop. At this point, an international seaweeds expert warned that traces of metals were approaching the tolerable limit of 10 ppm as the clean anhydrous yields (CAY) in recovered Philippine carrageenan continued to decrease. Goaded by traders to produce more on a very short pre-planting time, farmers were not taught or did not pay attention to recovering, recycling or properly disposing non-biodegradable plastic tying materials used in the culture. These were left to form large piles of rubbish on beaches or settle on the bottom of the reefs. The piles became so thick as to jeopardize the ability of the resource to recover. That said, seaweeds farming as a livelihood could still be a boon if properly managed and regulated. As farms are generally sited in open reef areas, it was feared to cause adverse effects on the coral reef environment. The influx of farmers to the site did create adverse effects on the local marine life. Extensive method of seaweed farming as practiced is still subject to certain constraints, in particular the access to and availability of sites. Due to their extensive nature, such practices require large areas of near-shore and coastal land and therefore tends to exclude the landless. It can also lead to conflict over resource use.

Box 5. Major threats to the industry

- Product is priced out of the market
- Shift by users to cheaper substitutes
- Illegal exports of seed and raw materials, i.e. smuggling
- Quality deterioration from pollution
- Competition from other producing countries
- Non-tariff trade barriers

Understanding sustainable seaweed farming and its ecological role in the marine environment is vital. Farmed in shallow water coastal environment, seaweeds serve as primary agents for the production of organic matter and energy on which the planktons, which provide the base for the productivity of the marine communities, thrive. Seaweed utilizes and dissolves carbon dioxide and water as raw materials in the production of organic matter through photosynthesis. It absorbs nutrients directly from seawater for growth. Thus, the presence of seaweed enhances the environmental condition for the other members of the marine community. Seaweed beds also serve as shelter and habitat for many associated marine animals.

The road traveled by Philippine seaweed industry has not been smooth. The years 1991-1993 were its most uncertain period, when the US was looking at the possibility of banning the Philippine Natural Grade (PNG) carrageenan. The issue whether PNG was safe for human consumption was later resolved in favor of the Philippines' claim that PNG is a natural food grade substance by the United States Food and Drug Authority (FDA).

Today, the Philippine's highly profitable seaweed export industry is facing stiff competition from other Asian countries, particularly Indonesia. The Philippines' annual production of 120,000 mt is second only to China's 275,000 mt. Although Indonesia's export of seaweed is still relatively modest, it could become the second largest producer in the near future. The Seaweed Industry Association of the Philippines (SIAP) has reported that there has been rampant smuggling of dried seaweeds in recent years in southern Philippines, a serious issue which the Philippine Government should address. The smuggled materials usually obtain better prices so that there is incentive to smuggling. If this continues, SIAP fears that Philippine processors will face high prices of raw materials.

Ironically, the high world market for processed seaweeds is creating some concerns (**Box 5**). The fear is the very high prices could pressure foreign buyers to find cheaper alternatives, leading to the possible "pushing out of carrageenan from the market". The existence of other raw materials in the world's "gum" market, which could be substitutes to carrageenan, is a major issue. Carbon methyl cellulose (CMC) and santhan could very well replace carrageenan if its price remained high or goes higher. The industry thus needs to exercise vigilance among its ranks and make sure that opportunism does not reign, with certain members setting the price of their products too high, which could prompt food additive users to shift from carrageenan to other materials.

Other issues are the shortfall of supply in the world market, and degeneration of raw seaweeds quality resulting in low carrageenan yield. The causes include premature harvesting, adulteration and bad post-harvest handling. The industry should also address possible trade barrier measures, which link environment, consumer and anti-poverty issues in the overall fisheries development policies of producing and exporting countries. For poverty to be alleviated among the poor dwellers in reef communities, seaweed farming must be made profitable to farmers, sustainable, competitive and made to come up with products of long-term and proven acceptability and utility.

Private Sector Initiatives

In the Philippines, it was the private sector that rationalized the seaweed industry. In the early 80s, some 18 small to medium-sized companies banded together to form the SIAP, turning SIAP into a national organization to promote the seaweed and carrageenan industry. Of the 18 companies, 11 were in processing. SIAP's aims include resolving issues, such as maintaining the quality of seaweeds produced in the country, price stability and efficient infrastructure for moving dried seaweeds from marine farms to processing plants and on to international ports.

Since the 60s, it took two decades for the Philippine seaweed industry to make a leap forward. This was realized through the efforts of Shemberg Marketing Corporation, a Cebu-based exporter of seaweed products, which established the first full-scale carrageenan refinery in the Philippines. Since 1986, Shemberg Marketing Corporation has penetrated the carrageenan markets of Western Europe, Japan and Australia. Shemberg predicts that carrageenan exports will increase by 15-20% annually, boosted by demand for the product from Europe.

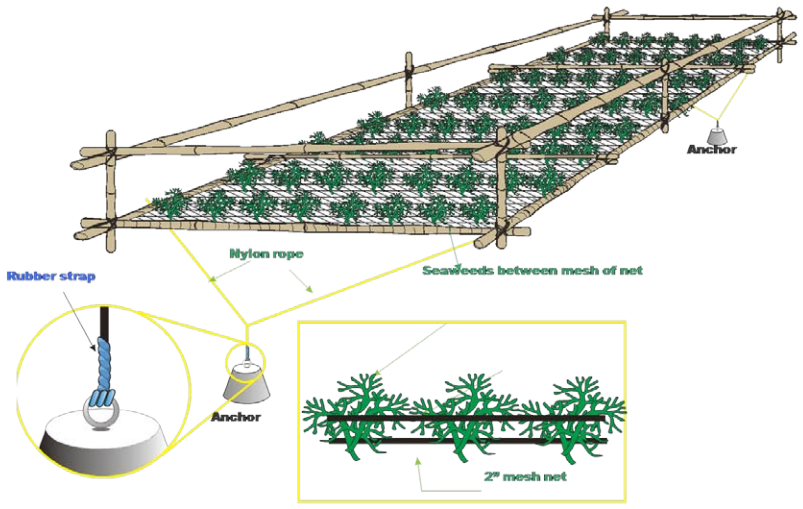
MCPI on the other hand, was instrumental in making the seaweed industry in the Philippines sustainable. Aside

Harvesting seaweeds (top) and drying seaweeds (above)

from trading carrageenan, it also promotes environmental conservation and coastal fisheries management in the seaweed farm areas. The once troubled and imperiled Danajon Reef has been transformed into a booming area for sustainable seaweed farming because of MCPI efforts. Danajon Reef is one of the few double barrier reefs in the world. Lying north of Bohol island in central Philippines, this double barrier reef comprises two sets of large coral reefs lying side by side. It occupies a total area of about 272 km^2 and measures 382 km long. The reef is dotted with some 18 islands and islets serving as breakwaters shielding mainland Bohol from strong winds and typhoons.

Until the mid-60s, Danajon Reef harbored a rich diversity of marine species. The rapid population increase in the whole country led to its coral reef kingdoms being subjected to intense commercial activities. Cyanide-using fishers destroyed the priceless cowries, abalones, tridacnas and sea horses in Danajon Reef. The lucrative business in tropical food and aquarium fishes nearly obliterated their once teeming population. Dynamite and fine-mesh fishing became the most popular means of fishing practices employed. The result was near destruction of a once pristine reef community. Impatient with the slow and little efforts from government to curb further despoliation of the once fertile spawning and municipal fishing grounds of Danajon Reef, the MCPI and other members of the private

Box 6. Lantay Method developed for Eucheuma farming by MCPI and promoted by DFI



Cage dimension:	Materials:		
Width: 2 m	2 bamboo poles	2 iron bars	anchors
Length: 5 m	10 m net (2" mesh)	10 m nylon rope	
Height: 1 m	1 ball plastic straw	1 m rubber straps	seedlings (25-35 kg)

sector in Bohol and nearby Cebu, conducted consultations with the fisherfolks. The consultations resulted in a "collective declaration of intent" advocating pro-active and concrete measures to stop illegal fishing practices. This development also led to the establishment of the Ocean Farming Research and Extension (OFRE) by MCPI and Datingbayan Foundation, Inc. (DFI). These organizations are responsible for the implementation of programs on seafarming supported by continuing education of the coastal community inhabitants on the problems posed by illegal and destructive fishing especially in Danajon Reef. OFRE promoted seaweed farming in Danajon Reef as an alternative source of livelihood. Under the arrangement specified in the "collective declaration of intent," the operations of OFRE became a responsibility of DFI, a non-profit organization working and assisting the fisherfolk in seaweeds farming and sea ranching in the Philippines.

The DFI has introduced viable economic endeavors through resource-based R&D incorporating the culture and processing of marine products of high commercial value. This approach saved the Danajon Reef from further deterioration and improved the livelihoods of the fisherfolk who depended on the reef, through seaweed farming. Today, Danajon Reef is among the high-producing areas for *Euheuma* spp.

Opportunities

Seaweeds farming is innately sustainable and environment-friendly. Seaweed biomass attracts various marine species and provides sanctuary and breeding grounds for marine life. It also contributes to ecological stability and sustained productivity in the reef areas. Eucheuma farming is a highly viable alternative source of livelihood, which fairly fits into the socio-economic circumstances of coastal dwellers. Often faced by declining catches and high cost of inputs, many fishers in the region usually resort to illegal or over-exploitative fishing. Seaweeds farming is an economic activity in which all members of the family, particularly the women, can take part. However, there is still lack of cohesive organization and trickling of benefits from better world prices down to the farming communities. The economic agenda of DFI are specifically tailored to remedy the problem of wealth-sharing by giving due reward to the farmers' toil.

Table 3. Standard quality requirements for marketing seaweed products

	Local Processor		Export Market	
	MC	Debris	MC	Debris
E. cottonii	35-42%	1%	35-38%	1%
E. spinosum	35-38%	1%	32-35%	1%

Common debris and foreign matters include: intentionally added salts, sand and gravel, plastic from tying materials used during culture

MC -- Moisture Content

Box 7. Lantay Eucheuma Seaweed Production System

I. "Lantay" Construction and Seaweed Planting

1. Straighten and cut bamboos or round wood to desired dimensions:
2 pcs. 5.2 m x 0.100 - 0.l20 m diameter
2 pcs. 5.2 m x 0.050 - 0.070 m diameter
4 pcs. 2.2 m x 0.080 - 0.100 m diameter
6 pcs. 1.0 m x 0.050 - 0.070 m diameter
2. Assemble the various pieces to form the "Lantay" bed using soft plastic straw "ties" or nylon twines
3. Cut 5m plastic 2" x 2" mesh net and spread one half across the "Lantay", tying with soft plastic straw
4. Spread evenly about 50 kilos of Eucheuma seedlings over the net bedding
5. Put the other half of the net as overlay on seedlings, effectively providing holdfast to avoid losing them from strong currents and wave actions
6. Fasten the net overlay with bamboo slats at 1 meter interval or as needed
7. Install the seeded Lantay in an appropriate location using nylon rope to anchor on rocks or anchor devises
8. Install a train (series) to form a module of twenty (20) "Lantays" set by pair of fives (5)
9. Watch the plantation with TLC (tender-loving-care) until harvest.

II. Harvesting & Post-Harvesting

1. Harvest the seaweed not less that 60 days from the date of seeding
a. Prune the seaweed leaving a part of main stem (thalli) to grow again; or
b. Harvest the whole bed.
2. Dry the harvest in an elevated platform made of bamboo slats. Cover the seaweeds with transparent plastic to bleach
3. The "Lantay" itself maybe used as a drying bed should a "total" harvest is done
4. Dry the seaweed harvest to about 35% MC, bag and store in a dry clean place

The prevalent culture systems for seaweed farming include: monoline method (bottom farm or floating long lines); modified net system (hanging nets, "lantay" (bamboo bed); and "sabwag" (broadcast), the most expensive but the most profitable. "Lantay" method is a recent innovation in seaweed farming developed by MCPI. "Lantay" is a Visayan word that means a bed made of bamboo. The "Lantay" Method (**Box 6**) makes use of an inverted bamboo bed. One advantage of this method is "lantay" can also be used later to dry the seaweeds after a complete harvest. The detailed production system and projected income of farmers for seaweed farming using "Lantay" are shown in **Box 7** and **Box 8**, respectively.

With the monoline method, an area of 2500 m^2 (0.25 ha) is the ideal size for one family to operate; 500 monolines of 10 m length, spaced 0.5 m between lines can be accommodated. This would give a harvest of 12,500 kg fresh seaweeds a month on a 60-day harvest cycle. This can provide a family an annual income of USD 4000 from an investment of USD 800.

A large portion of the costs in seaweeds farming is taken up by the initial planting because planting materials are bought from suppliers some distance away from the coastal areas thus, involving high transport costs. In the succeeding planting seasons, the operating costs become much less as the materials can be recycled. Fixed costs constitute mostly of operator and family labor and hired caretaker(s) as well as some workers. Other expenditures include capital expenses for the farmhouse and drying platform, pumpboat, dugout canoe, hand tools, and other equipment, and interest on loans, depreciation charges, municipal fees and other fishing permits, as well as maintenance and repair of equipment. Processing of seaweed into semi-refined carrageenan involves simple technology. With the exception of Shemberg Marketing Corporation, the industry has limited itself to the production and export of semi-refined product where quality control is not as stringent and demanding as that for refined carrageenan.

Servicing the Seaweed Farmers

Among the other commitments of DFI is the provision of technical training and seedling sourcing, formation of cooperatives, institutional capability building; linking farmer organizations to funding sources; and assisting farmers in marketing their produce. The MCPI on the other hand, assists the farmers in marketing their produce upon compliance with its requirements, i.e, adopting prevalent cultivation system that are environment-friendly; proper post-harvest processing and handling; market classification and standards; and raw seaweeds quality standards set by MCPI. Seaweeds should be sun-dried with moisture contents (MC) not to exceed 38% and impurities or foreign matters not more than 1% (**Table 3**).

Fresh seaweeds are also sold in local markets as these form part of a salad delicacy known as "guso" salad. Semi-dried produce could also be sold to local carrageenan

Box 8. Farmer's Projected Income (20-"lantay" module, occupying about 300 m² of ocean space)		
Lantay Costs (in PHP)	Per lantay (PHP)	Per Module (20 lantay), PHP
Bamboo (2 Poles)	100.00	2,000.00
Nylon Nets, Nylon Rope, Nylon twine/straw, etc.	200.00	4,000.00
Anchor (cement blocks or steel bars)	200.00	4,000.00
Seedlings (35 kg @8/kg), etc.	280.00	8,000.00
Total Initial Cost	**780.00**	**18,000.00**
Income (Dried Harvest): Starting 3rd month, 10 lantay@50kg = 500 kg		500 kg
Gross Revenue Per Month (Farm Gate Price: PHP 35/kg),		17,500.00
Total Income Per Year (No. of Harvest-1st year: 10X)		**175,000.00**
Net Farmer's Income		**157,000.00**

manufacturers. In any case, MCPI sees to it that the producers comply with the basic standard requirements. MCPI reported that there has been records of recent substantial export from the Philippines that were rejected and returned by Chinese and European buyers due to poor quality.

The complex market structure through which the produce is channeled could contribute to the deterioration of the quality of the product. The market channel starts from: (1) the farmer-producer who may also serve as collector or assembler; (2) to the small traders who act as middlemen or perhaps small-scale assemblers or wholesalers; (3) to the large traders who are mainly agents; and finally (4) to the exporters or the processors sometimes serving also as exporters.

Some progressive farmers who have the means to transport and sell directly to the big exporters and/or processors pass through a shorter route than the small-scale farmers. The produce of the small-scale farmers usually goes through a series of middlemen before reaching the exporters and/or processors. Since the exporters or processors determine the buying price, the small-scale farmers who represent the majority of the producers receive only a small share of the profit. A large chunk goes to the middleman, assembler or wholesaler. The large-scale exporters/processors serve sometimes as subsidiaries of foreign processors or independent exporters or processor-exporters.

Conclusion and Recommendations

The increasingly diversified applications of carrageenan have expanded the market for seaweed and carrageenan. Recently, it has been utilized in medical syrups as it provides excellent suspension of the antibiotic ingredients. The gel foam in air fresheners has been added to the list of carrageenan's industrial uses. These and the other uses mentioned earlier will continue to raise demand easily doubling or even tripling in two to five years. The Philippine domestic market for carrageenan is also expanding. Local food and toothpaste manufacturers have begun using carrageenan. SIAP estimates that the annual requirements of the ham industry alone (carrageenan is a binder in ham-making) for carrageenan will reach 2000 mt, which is valued at PHP 375 million.

The local processing plants have established state-of-the-art processing plant facilities, but there is need to promote vigorously the product in world markets. In order to meet the growing demand for seaweed, the country needs to develop new farming areas. In addition, the Philippine Government should promote improved production and culture techniques, and uniform quality standards in seaweeds buying. The private sector needs assistance in improving product quality. This would include research on seedling selection, better techniques for productive and environment-friendly culture systems, and quality improvement. There is need to establish common harvest facilities and promote cooperative marketing. The private sector needs logistics support to continue bridging the link between the farmer beneficiaries with reliable exporters so that the farmers can obtain a fair price for their product.

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Towards Sustainable Coastal Development in Thailand: Marine and Coastal Resources Policy Green Paper

Yves Henocque and Sanchai Tandavanitj

This Policy Brief, which takes into consideration the key findings of the Marine and Coastal Resources Policy Green Paper, has been proposed to the Department of Fisheries of Thailand as the CHARM implementing agency and to the Department of Marine and Coastal Resources as the Secretariat of the National Sub-Committee on Marine and Coastal Resources Management under the aegis of the National Environment Board and the Deputy Prime Minister.

The Green Paper and its Policy Brief, which were prepared by the CHARM Integrated Coastal Management Group (Box 1), are the products of years of local coastal resources management initiatives and specialist studies carried out along the coast of Thailand including the last five years of operation of the Coastal Habitats and Resources Management (CHARM) and partners' coastal co-management experiences on both the Andaman coast and the Gulf of Thailand. CHARM is a collaborative project of the European Union (EU) and the Government of Thailand. Workshops have been held to obtain feedback for the Green Paper. Based on this feedback a paper was prepared with the objective of setting out Thailand's future policy on coastal resources management, where its progressive implementation could start through appropriate institutional and legal arrangements in the implementation of priority programs and demonstration projects. The Environmental Management Program and its Marine and Coastal Resources Management Plan is envisaged to generate wide public support for a new and innovative policy while the civil society's growing strength could be harnessed to develop a shared responsibility for sustainable coastal development. This Policy Brief presents the need for a Marine and Coastal Resources Policy, a vision for Thailand's coasts well as the principles, goals and objectives for coastal resources management. It also presents possible institutional and legal arrangements for implementing the proposed Marine and Coastal Resources Policy.

Box 1. The CHARM Integrated Coastal Management Working Group

1. Udom Batiyasevi (Coastal Zone Management Specialist)
2. Tassanee Janjariyaporn (Community Development Department)
3. Songdham Sooksawang (National Park Department)
4. Pakorn Prasertwong (Marine Department)
5. Raweewan Puridej (Office of Environment Planning)
6. Wannakiat Tabtimsang (Marine and Coastal Resources Department)
7. Thongchai Towanapong (Union Frozen Co. Ltd.)
8. Suwalack Satumanatpan (Environment and Resources, Mahidol University)
9. Kungwan Jantarachote (Fisheries, Kasetsart University)
10. Pakpum Witantirawat (Economic and Social Advisory Board)
11. Tanu Nabnian (Worldwide Fund Thailand)
12. Chaipat Chaisawat (Local Administration Department)
13. Representatives of Thai Travel Agents, and Provincial Administration Department
14. Sanchai Tandavanitj and Yves Henocque (CHARM Co-Directors)
15. Damrong Silpachai (CHARM Legal and Institutional Specialist)

Need for a Coastal Policy

Thailand's coast is a rich national heritage which provides enormous benefits to its people. It offers many opportunities for future economic and social development, particularly in under-developed areas of the country. At present, the value of coastal ecosystems as a cornerstone for development has not been appropriately acknowledged in decision-making processes. The country's valuable coastal assets together with the future development opportunities will only be squandered unless the diversity, health and productivity of coastal ecosystems are maintained. Thailand needs to invest in coastal resources management to realize and sustain the benefits and opportunities that its coast could offer. A radical new approach is needed to manage the coastal resources wisely and to harness them for sustainable coastal development. A Coastal and Marine Resources Policy is therefore crucial in achieving this change. The CHARM Green Paper sets out a new approach to marine and coastal resources management that aims to: realize the coastal benefits; sustain coastal benefits; and promote proactive and cooperative governance.

Realizing Coastal Benefits

Thailand's maritime area covers over 378,000 km2 including the territorial waters extending 12 nautical miles from the coast and the Thai EEZ. Two-thirds of the area (252,000 km2) covers the Gulf of Thailand and the rest

(126,000 km2) in the Andaman Sea. The total coastline length is 2,880 km with 1,920 km on the Gulf of Thailand and the remainder along the Andaman Sea in the southwest. Of the country's 76 provinces, 23 including Bangkok are coastal provinces. Thailand is endowed with rich coastal and marine resources, world class tourist destinations amidst its sparkling beaches and coral reefs, and an extensive coastline that is home to 25% of the nation's population. Together, coastal and marine ecosystem goods and services account for 5% of the GDP.

But coastal ecosystems have an economic value that goes beyond the marketing benefits supporting human lives and livelihoods through the provision of food and materials, nutrient cycling, waste processing, and other essential goods and services. In addition, the country's coast has significant aesthetic, cultural, educational, scientific and spiritual value that also offers future development prospects exceeding those available in most other areas of the country. Thailand's coast therefore provides an important basis for the country's future economic development, poverty reduction and sustainable job creation.

Sustaining Coastal Benefits

Providing benefits on a sustained basis to all is only possible if the coastal ecosystems on which those benefits depend are wisely managed. This means managing the coastal ecosystems in a way that recognizes their inter-connected nature. Since coastal ecosystems involve complex biological, chemical and physical inter-relationships between land and sea, the coast is a high-energy environment that is subject to constant change. These conditions give rise to a variety of landforms, plant and animal species and habitats, and to an abundance of natural resources.

The coast is also the site of complex inter-relationships between humans and natural systems. Although coastal ecosystems are resilient, they are finite and vulnerable to over-use, pollution and damage. Inappropriate decisions can expose human life and property to high risks. While many activities take place at the coast, these are seldom coordinated, reducing the overall benefits. Without effective management, many coastal resources would be over-used and degraded to the point where social and economic benefits can no longer be drawn from them. Specifically, Thailand's coast requires a dedicated, coordinated and integrated management approach to sustain the coastal ecosystems on which the coastal benefits depend.

Promoting Proactive and Cooperative Governance

Current institutional and legal arrangements for coastal management seem inefficient and fragmented, and fail to coordinate the many activities taking place at the coast. A proactive Marine and Coastal Resources Policy is therefore needed to promote harmony between sectoral policies, strengthen institutional arrangements, promote coordination and integration of planning, management and investment strategies, and strengthen the human resource base for coastal management.

The Green Paper proposes an approach to coastal management that emphasizes facilitation rather than regulation. It promotes cooperative governance and public-private partnerships to promote a shared responsibility for the management of the country's coastal heritage, and also suggests mechanisms for coordination and integration between different sectors. In order to develop and implement this new approach, an investment must be made in coastal management. It is only in this way that the diversity, health and productivity of coastal ecosystems could be maintained, and thereby realizing and sustaining the benefits and opportunities that the coast provide. Failure to make such an investment will leave many coastal communities in poverty and reduce options for future development.

Vision and Principles

The proposed Marine and Coastal Resources Policy must be based on accepted public values and should provide a clear guidance for addressing issues of public concern. First, an agreement should be reached on a national vision for the country's coast followed by the appropriate principles, goals and objectives for coastal management. Possible institutional and legal arrangements can then be developed and considered, ensuring that the policy is implemented in a practical and proactive way in order that issues of concern are addressed and the vision is realized.

Still in its infancy, a proposed vision statement (**Box 2**) has been derived from many vision statements collectively identified at the local level. Although many proposals were presented, a shared collective vision at national level was lacking so a proposed vision was established based on certain principles for coastal management (**Box 3**).

Goals and Objectives

The goals and objectives (**Box 4**) of the Coastal Policy have been organized along with the conceptual framework of the five-year (2007-2011) Environmental Management Plan as adapted to coastal zone management issues. These are: Goal 1: Community empowerment; Goal 2: Improvement of management framework; Goal 3: Mobilization of local administration; Goal 4: Livelihoods development; Goal 5: Enhancement of natural resources; and Goal 6: Restoration and monitoring

Box 2. Proposed National Vision

Collectively to help conserve natural resources and enhance environmental quality for society emphasizing: 1) the beautiful scenery; 2) a clean and good water quality and environment; 3) the equity of marine and coastal resources exploitation; 4) the ecological balance; and 5) wealthy aquatic resources.

Box 3. Principles for Coastal Management

National heritage. The coast should be retained as a national heritage, with public rights to access and benefit from coastal resources

Economic development. Coastal economic development opportunities should be optimized to meet basic human needs and to promote human well-being

Social equity. Coastal management efforts should ensure that all people, including future generations, are treated with dignity, fairness and justice

Ecological integrity. The diversity, health and productivity of coastal ecosystems should be maintained

Holism. The coast should be treated as an indivisible system, recognizing the inter-relationships between coastal users and ecosystems and between the land and the sea
Risk aversion and precaution. Coastal management efforts should adopt a risk-averse and precautionary approach under conditions of uncertainty

Duty of care. Coastal management is a shared responsibility, thus all people should be responsible for the consequences of their actions, and have the duty to act with care to avoid damage to others and their coastal environment

Coordination and integration. Coastal management efforts should be coordinated and integrated, and conducted in an open, inclusive and transparent manner

Institutional and Legal Arrangements

Institutional arrangements

Appropriate institutional and legal arrangements need to be considered while the preferred arrangements should be put in place. This will require the participation and support of all spheres of government, the private sector and civil society. Furthermore, it would also require the harmonization of policies and actions of institutions responsible for different aspects of coastal management.

National Level

In the short and medium-term, the most appropriate vehicle for a national coordination is the Subcommittee for Marine and Coastal Resources Management, recently set up through the National Environmental Board (NEB) under the Deputy Prime Minister's authority. The Subcommittee is primarily responsible for consideration, approval and follow-up of national marine and coastal resources management policies and plans, checking compliance of line Ministries with the Coastal Policy, harmonizing sectoral activities and fostering

Box 4. Objectives corresponding to each goal
GOAL 1: Community Empowerment • Enhancement of coastal and fishery resource management by community • Zoning of conservation area with people's participation • Enhancing coordination among community, with government and concerned parties • Promoting awareness on conservation and utilization of marine resources • Community empowerment for community based mangrove ecosystem management • Promoting study, research and develop marine and coastal resource database • Collecting local knowledge and wisdom concerning coastal resource management (CRM)
GOAL 2: Improvement of Management Framework • Creating motivation and mechanisms to reduce fishing capacity • Controlling and zoning of fishing ground and conservation area • Disseminating updated information about catches to assess fishery resources supply • Developing rules and regulations for organizations concerned with CRM
GOAL 3: Mobilization of Local Administration • Strengthening of local administration organization for CRM • Encouraging local administration organizations to participate in CRM • Encouraging local administration organizations to participate in pollution control
GOAL 4: Livelihood Development • Promoting integrated fish culture and develop alternative livelihoods • Enhancing coastal fishing capacity • Increasing added-value of marine products • Setting up Community Seafood Bank • Developing mangrove forest into a center of nature study and eco-tourism • Setting up resource utilization rules to minimize conflicts and compliance with rules
GOAL 5: Enhancement of Natural Resources • Evaluating the carrying capacity of natural resources in the Thai seas and major freshwater courses • Developing fish culture technologies • Providing incentives for sustainable and balanced utilization of natural resources
GOAL 6: Restoration and Monitoring • Restoring fishery resource production at the level of other countries' stocks • Overseeing and controlling environmental quality management of production areas to meet international standards

strategic alliances. The Department of Marine and Coastal Resources (DMCR) serves as its secretariat.

Provincial Level

The Provincial Administration Act (1997) has mandated the Provincial Administration Organization (PAO) to protect, take care and maintain/enhance the natural resources and the environment. As proposed in the draft on Promotion of Marine and Coastal Resources Management Act, the Provincial Marine and Coastal Resources Committee would be led by the Governor as Chairman and the Head of Provincial Office as the Vice-Chairman with qualified members coming from the main department regional offices. It will be in charge of the preparation and submission of Provincial Marine and Coastal Resources Management Plans complying with the national policy while the Provincial Natural Resource and Environment Officer would act as member and secretary.

Local Level

The local sphere of government is responsible for a wide range of executive functions relating to coastal management. The Sub-district Administration Organization Act gives the Tambon Administration Organization (TAO) the authority to develop their respective sub-district in terms of economic, social and cultural aspects including the protection, maintenance and enhancement of the natural resources and the environment. The TAO may issue district regulations as long as they are not against the general law or the TAO roles and functions. Following the draft on Promotion of Marine and Coastal Resources Management Act, it would be supported by the Village- or Tambon-level Local Marine and Coastal Resources Committees.

Day-to-day coastal management

Since the great majority of day-to-day coastal management work takes place at local government level, the ongoing executive functions of TAO, municipalities, district councils and traditional leadership structures should include natural resource management, waste management, local economic development, environmental health, and tourism promotion. Currently, the capacity levels of local authorities along the coast greatly vary. Since the long-term aim of the national policy is to ensure that the capacity of local government is developed, coastal considerations should therefore be effectively incorporated into this mainstream work. In the short-term, the focus should be on education and training programs for local and district councilors or the so-called "Coastal Community Officers" and officials, traditional leaders and community-based organizations. These programs should explore the implications of the national policy for coastal management at local level, and may be accompanied by the development of guidelines for local coastal management by the National Marine and Coastal Resources Committee in consultation with provincial lead agents. In areas where local political and administrative structures are weak, a Provincial Marine and Coastal Resources Committee funded by government and donors will provide assistance where possible with the aim of strengthening the structures' overall capacity.

Building co-management

A long-term aim of the national policy should be the establishment of local- and regional-level coastal forums and networks in as many coastal areas as possible in order to promote dialogue between government, business and civil society stakeholders. The existing Andaman Triangle Network has been capable of leading the sharing of information and better communication between the Tambon communities and local authorities up to the provincial level.

In the short-term, the Provincial Marine and Coastal Resources Committee and lead departments' provincial offices should assist in developing these local coastal forums wherever possible. One such promising network is the Integrated Coastal Management (ICM) Local Governments Network initiated by the Partnerships in Environmental Management for the Seas of East Asia (PEMSEA) regional project, recently expanded through the CHARM national project. When local environmentally oriented forums already exist like fisheries forums, catchment management forums, advisory forums and subcommittees of development forums, the possibility of using these existing structures to address coastal issues should be explored. Such local coastal forums and networks may be in a position to advise local authorities in dealing with detailed coastal management issues in a practical way. Having sectors of local government represented in such forums could as well assist the Provincial Marine and Coastal Resources Committees in achieving coordination between these sectors and in ensuring that coastal considerations are incorporated in the provincial coastal management plans.

Managing local demonstration projects

Another key aspect of implementation of the national policy at local level is the selection and possible extension of a number of local demonstration projects along the coast in the short-term. The existing coastal management-related projects should be part of a nationally coordinated Plan of Action, and should be systematically used to provide experiences and lessons learned about the way co-management and finally integrated coastal management should be promoted. Capacity building for demonstration project management structures should be one of the focus areas of national/provincial education and training programs by developing the members' organizational, financial and coastal management skills. In each province, a coastal coordinator should assist management structures in becoming operational in the medium-term. In the longer term, this should lead to the further development of structures to run local coastal management initiatives like co-management arrangements or public-private partnerships on a self-sustaining basis.

Non-Government Roles and Functions

Achieving the ideal of sustainable coastal development depends on the establishment of partnerships and co-responsibility between the government, the private sector, civil society organizations and the research community. The proposed responsibilities of the non-governmental role-players are outlined below, with particular focus on short- and medium-terms.

Private sector

The private sector has a critical role to play in achieving effective and integrated coastal management. Stakeholders with commercial interest in fishing, aquaculture, agriculture, forestry, industry, tourism, and property development have direct interest in and the responsibility for protecting coastal ecosystems in order to sustain the flow of coastal goods and services on which their businesses depend. Where appropriate, these businesses should incorporate coastal management issues in their safety, health and environment programs.

Civil society

Every day, civil society shows valuable role in mobilizing support for coastal management and in carrying out monitoring, research and awareness building as well as education and training functions. A number of developmental and environmental NGOs have been instrumental in raising public awareness of coastal issues in Thailand specifically on the need to conserve coastal resources and ecosystem services and functions for the benefit of coastal communities. In particular, many NGOs have also played central roles during emergency, e.g. during the 2005 Tsunami, as well as in initiating and supporting local demonstration projects along the coast, particularly in under-resourced parts of the coastal provinces.

Community-based organizations (CBOs) in coastal communities are often centrally concerned with the utilization of coastal resources and the promotion of economic development opportunities. This places the CBOs in a critical position to influence coastal management and to assist in achieving sustainable coastal development. In particular, local demonstration projects based on co-management approaches can generate community support, while ensuring that these projects meet the basic needs of coastal communities. CBOs should also play a valuable role in gathering and disseminating information through the development of Information and Learning Centers in order to contribute to such efforts as public awareness, education and training. In particular areas of the coast, specific user-groups, such as sea gypsies, recreational anglers and sailors, should also be involved as stakeholders in specific coastal management activities.

Research community

The research community has special roles to play in research, monitoring, public awareness building, education and training and in providing specialist support for coastal management. In Thailand, tertiary institutions including universities and research institutions have been at the forefront of coastal research, providing the knowledge base for the development of thinking on coastal management issues. In collaboration with the government agencies and the civil society (NGOs, CBOs), further applied research should be developed in both the natural and social sciences contributing to a better understanding of the biophysical and socio-economic state of the coast.

Legal arrangements

Most of the substantive issues involved in managing the coastal zone and marine areas are already governed by existing legislations. Other laws in force regulate the sectors and industries that impact the coastal zone and marine areas, in particular the Ministry of Agriculture and the Department of Fisheries of Thailand. This conventional approach to regulation means that coastal and marine resources are governed piecemeal. Although the provisions of sectoral laws are implemented within each sector, little or no regard is put on the effects of implementation of the regulations on other sectors or coastal communities. Besides the need for possible revision and adjustment of these laws for better harmonization, there is also a need for a legal framework that recognizes coastal communities and gives them legal personality while providing an inter-ministerial, cross-sectoral committee mechanism to coordinate all of the governmental actors that already operate in the coastal zone and marine areas. The draft Promotion of Marine and Coastal Resources Management Act, prepared in 2006 by the Department of Marine and Coastal Resources (DMCR), attempts to do this as well as implement constitutional efforts that guarantees of citizen's rights to participate in natural resource management through access to information and participation in decision-making.

If adopted as drafted, it would provide a framework within which the multiple government authorities operating in the coastal zone and marine areas can coordinate and harmonize their functions, and provide for resolving conflicts of jurisdiction among government authorities and for resolving disputes among stakeholders. The issues of allowing citizens participation in resource management and of sharing benefits with local people have a long history of being highly contentious in Thailand. If this draft Act can be adopted with its co-management and benefit-sharing provisions relatively intact, it will provide a precedent for governing other types of ecosystems as well. The draft is now in the hands of the Minister of Natural Resources and Environment for consideration and submission to the Secretary-General of the Cabinet, at which time a standard governmental process of vetting a draft law will begin. It may be anticipated that the draft Act will be revised several times before being submitted to the National Assembly for debate and adoption.

Next Steps

September to November 2007

Meetings and workshops will be held in the coastal regions during this period, to assist interested and affected parties in developing a good working knowledge of the Green Paper. The meetings will also provide opportunities to identify matters of concern in the Green Paper and to suggest alternative policy proposals as well as seek as much better agreement as possible on matters relating to the coastal regions and provinces.

December 2007 to April 2008

The regional and provincial gatherings will provide the basis for preparing a draft national Coastal Policy document that were distributed before the end of 2007 for public comment. This draft policy will form the basis for a National Policy Event(s) in early 2008. The policy formulation phase of the Coastal Management Policy Program will be concluded at the end of April 2008. This is envisaged to set the scene for the Government of Thailand to adopt and implement a new Marine and Coastal Resources Policy in 2008.

Feedbacks

The purpose of the Green Paper is to stimulate discussion and debate about the most appropriate approach for managing the marine and coastal resources of Thailand. Feedbacks to the further development of the policy are being collated. Further information about the Green Paper and coastal co-management issues can be obtained on www.charmproject.org where full-text project documents and reports can be downloaded.

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Promoting the culture of gilthead sea bream (*Sparus auratus* L.) in low saline inland water:

A novel way to farm saltwater fish in freshwater

Samuel Appelbaum, A. Jesu Arockia Raj and Ch. Iman Raj

A group of researchers from the Bengis Centre for Desert Aquaculture, Ben-Gurion University of Negev, Sede Boker Campus in Israel has developed a novel technique of culturing saltwater fish in freshwater environment by adding salt in the fish diets. Although developed in Israel, this novel method could also be adopted in the Southeast Asian region to promote the aquaculture of high-value marine fishes in the region's large freshwater bodies paving the way for abating the economic and development disparities in the region's aquaculture industry. The results of the work conducted by the researchers are laid out in this article.

Sea bream (0.4±0.14 g) were reared in three water salinities 3.0, 5.5 and 7.0 ppt by mixing brackish water (2.5 ppt salinity) taken from a local brackish geothermal subsurface aquifer with Dead Sea salt. The 140 days experiment was conducted in 60-liter (l) rearing tanks in a re-circulating system. Three diets were used in the experiment: Diet 1 "Denis premium 1" (54% protein and 14.5% fat; manufactured by RMC Ltd, Israel), which served as the control diet; Diet 2 and Diet 3 which were prepared by adding 0.5% and 1.5% Red Sea salt, respectively to the control feed, fine grounded and re-pelleted. Fish were fed ad libitum five times daily. Fish reared in 3.0 ppt salinity and fed the diet containing 1.5% salt grew significantly ($p<0.05$) better than those fed the control diet. In 5.5 ppt and 7.0 ppt salinities, fish fed the control or the salt rich diets did not differ significantly in growth among the groups regardless of the diets given. Adding 0.5% sea salt to the diet promotes better survival of the fish reared in 3.0 ppt salinity (42.1%) and 7.0 ppt salinity (50.7%). The specific growth rates (SGR) of fish reared in 5.5 ppt and 7.0 ppt salinities and fed the control diets was lower than those fed salt rich diets, although statistically the difference was not significant. In contrast, fish reared in 3.0 ppt salinity and fed the diet containing 1.5% salt had significantly higher SGR than those given the control diet. The present results indicated that the effect of salt-enriched diet on sea bream is more pronounced when reared in lower salinity. Fish culture in low water salinity opens up promising opportunities for the production of sea bream and other euryhaline fish species in arid regions holding brackish water.

Gilthead Sea Bream

Gilthead sea bream (*Sparus auratus* L.) is a euryhaline teleost capable of living in environments of different salinities ranging from 2 ppt to 60 ppt (Laiz-Carrion et al. 2005). *S. auratus* is found in the natural habitat from the Mediterranean and Black Sea to the eastern Atlantic Ocean from Senegal to the United Kingdom (Kissil et al. 2000). It usually inhabits the shallow lagoons along the coasts, but migrates into deeper waters to spawn after late autumn. In commercial rearing units, the early larval stages after yolk absorption (3-4 days) are fed with rotifer (e.g. *Brachionus plicatilis*) followed by *Artemia* after 12-15 days post hatching and this is continued up to 32-35 days post hatching.

The sea bream larvae should be fed with commercial lipids and fatty acids enrichments along with rotifer and Artemia, mainly for normal growth, development and survival. The larvae could then be weaned at 5-10 mg size with 50-60% high protein formulated diet.

Acclimation into Low Saline Waters

Adaptation of euryhaline fish into different environmental salinities induces changes/activation of its iron transport mechanism. This is usually accompanied with changes in oxygen consumption, suggesting variations in the energy demands for osmoregulation (Sangiao-Alvarellos et al. 2003). Sea bream rearing in low saline waters has been successfully tried in many research experiments giving a number of possibilities for culturing the fish in low saline inland waters. This would create an important expansion of aqua-business ventures which can be adapted in many regions. Cultivation practices of sea bream in the Mediterranean region (annual production ~ 150,000 mt) vary due to the region's environmental conditions.

However, since inland low saline water is deficient in its mineral (salt) content, adding the required salt into the diet of the fish could produce better results in terms of growth

and survival (Harpaz et al.2005). Sea bream could also be explored as potential candidate species for such culture system using marine, brackish or low saline inland waters. Fish adapted to low saline water exhibits a passive outward flux of ions such as Na+ and Cl- to the water via the gills, faeces, and renal system, which must be compensated by the active uptake of ions (e.g., Na+, Cl-, K+, and Ca2+) from the water and/or from the diet. The diet of fish therefore, constitutes an important source of salts that can satisfy the osmoregulatory requirements particularly when fish are kept in low saline water, thus sparing energy used for osmoregulation and reserving more energy for growth. It has been shown that the salinity of the rearing water has some influence on feed intake in rainbow trout. In high saline water (up to 28 ppt), feed intake usually increases but the growth rate decreases affecting feed conversion ratio. Yet, in euryhaline species, salinity affects growth in various ways and maximum growth is not always obtained under isosmotic conditions.

Salt Addition in Diets

Many researchers have addressed the issue of using dietary salt to help alleviate the problems associated with transferring salmonids to seawater or saltwater growing conditions. The results have shown a marked advantage in the use of dietary salt resulting in better survival. Even the transfer of tilapia, a freshwater (non-anadromous) species to saltwater (15-20 ppt) conditions was easier for the pre-acclimatized fish by adding salt to their diet (Fontainhas-Fernandes et al. 2001). Addition of salt to the diet of fish has several advantages as it increases appetite and also acts as a humectant by reducing water activity. Although the effect on the growth of fish may not be very clear, some studies have attained positive results. Some researchers may have considered this experiment advantageous but others reported that the growth in young coho salmon was hampered even with the addition of only 1.5% salt resulting in a 7% weight gain reduction (Fontainhas-Fernandes et al. 2000; Nandeesha et al. 2000; Eroldogan 2003).

It should be noted that in the analysis of the mineral composition of various fish feeds available in the market, the content of salt in these feeds could be 1.5% on the average but could also be as high as 6.0% especially in the case of feeds used for the early stage of salmon fingerlings. A large percentage of the dietary salt in commercial feeds for carnivorous fishes originates from the fish meal component of the diet. This is one factor therefore, that should be taken into account when replacing fish meal with various plant-derived meals which are not rich in salt. Nonetheless, it should also be considered that better utilization of the food is dependent on the digestion and absorption capabilities of the fish.

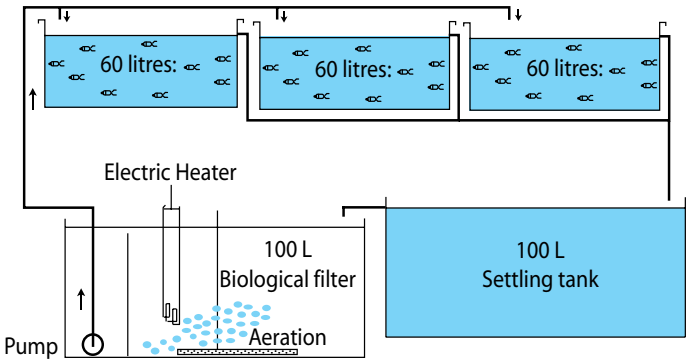

Fig 1: The experimental setup (showing one of three units)

Research Methods and Findings

The nine rectangular rearing tanks (60-l capacity each) used for the experiment were grouped into three separate re-circulating systems with each system consisting of three rearing tanks connected to a separate water-cleaning unit so that all three replicates share the same water parameters through the water circulation unit. The water-cleaning unit (100-l tank), which is filled with volcanic gravel and strongly aerated acts as a biological filter (**Fig. 1**). Filtered water enters each rearing tank at the rate of 3.2 l/min while 15 l of water were replaced daily in each of the three systems.

The salinities of the three systems were prepared by using local brackish water of 2.5 ppt salinity pumped from a brackish geothermal aquifer resting deeply subsurface, into which Dead Sea salt (**Table 1**) was added to prepare the required water salinities of 3.0 ppt, 5.5 ppt and 7.0 ppt for the experiment. Continuous aeration was provided by a blower and diffused air stone in each of the rearing tanks while maintaining the oxygen levels in the water at >4 ppm. The fish in the rearing systems were subjected to natural photoperiod while water temperature was maintained at 27±1ºC throughout the experiment using thermostatically controlled heaters (Jagers, Germany). Total ammonia and nitrite were kept at levels below those determined as limits for the sea bream. On day 74 of the experiment, fish were transferred to larger tanks (100-l capacity) for further rearing.

Table 1: Composition of Dead Sea salt (Dead Sea Works Ltd, Israel)

Major elements	Percentage composition
Sodium chloride	98.3
Sulphates	0.5
Calcium	0.3
Magnesium	0.15

Sea bream fingerlings (average weight: 0.4±0.14 g and average length: 2.6± 0.09 cm), produced by Ardag Limited, Eilat, Israel were used for this feeding trials. The three different diets used in the experiment were: Diet 1 "Denis premium 1" feed (Shivuk Raanan, Israel) containing 54% protein and 14.5% fat serving as the control while Diet 2 and Diet 3 were prepared by adding 0.5% and 1.5% Red Sea salt (Red Sea Fish Farm Limited, Eilat), respectively to the "Denis premium 1" feed, which was ground and re-pelleted after adding the salt using a feed pelletizer machine (WLS Loser, Germany). The resulting pellets were oven dried at 60ºC for 6 hours and later stored in air tight containers. Fish in all the tanks were fed ad libitum five times daily by hand. Uneaten feed and excreta were siphoned out daily to minimize water pollution.

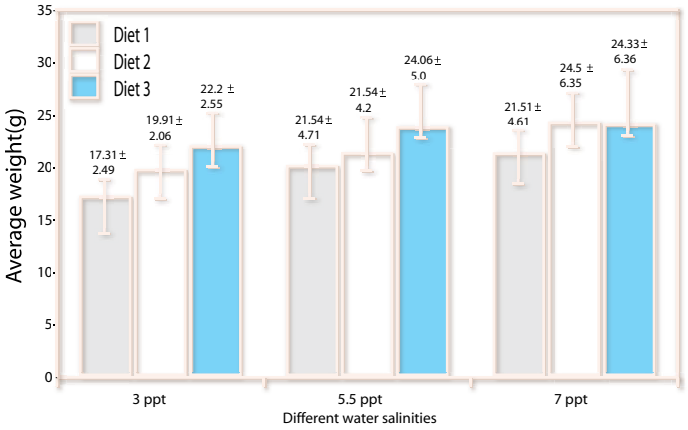

Fig 2: Final weight of gilthead sea bream reared in different salinities fed different salt-enriched diets for 140 days

Although all experimental diets were equally accepted by the fish, those reared in 3.0 ppt salinity and fed the diet containing 1.5% salt grew significantly better ($p<0.05$) than those reared in the same system but fed the control diet. The fish reared in 5.5 ppt and 7.0 ppt water salinities and fed the control or the different salt-enriched diets did not differ significantly. Adding 0.5% sea salt to the diet promoted better survival in 3.0 ppt salinity (42.1%) and 7.0 ppt salinity (50.7%). The specific growth rates (SGR) of fish reared in 5.5 ppt and 7.0 ppt salinities and fed the control diets was lower than when fed salt rich diets, but statistically not significant. In contrast, when reared at 3.0 ppt salinity and fed the diet containing 1.5% salt the SGR was significantly higher than the control diets (**Table 2** and **Fig. 2**).

In a related study, Salman and Eddy (1987) have reported that the food intake and appetite of the rainbow trout were not affected by salt addition to the diet but the addition of salt did enhance the growth of the fish. They also observed a positive linear relationship between the increased level of salt in the diet and in the chloride cell numbers and gill Na+/K+ -ATPase activity. This confirms that fish reared in saltwater are also exposed to additional salt from their food.

However, such quantity of salt is negligible compared to the overall amount of salt from the environment that the fish absorbs through their intestines and body surface. This could explain the trend which the present experiment showed that fish reared in higher salinity achieved higher weight than in lower salinity but not significantly. In another experiment, Gatlin et al (1992) reported that juvenile red drum exhibited greater feed efficiency and significant weight gain when 2% NaCl was added to their diet. In the case of barramundi, adding 4% salt to the diet resulted in significant improvement in their feed conversion ratio (FCR) (Harpaz et al. 2005). In the same experiment, the addition of salt was reported to enhance the activity of the brush border enzymes alkaline phosphatase, lactase, and to some extent, leucine amino peptidase.

The improved enzymatic activity in the fish resulted in better absorption and digestion of food especially in carnivorous fish like the sea bream. In the present study, the SGR of fish reared in 5.5 ppt and 7.0 ppt salinities and fed the control diets was lower than those fed the salt-enriched diets, but statistically not significant. In contrast, fish reared in 3.0 ppt salinity and fed the diet containing 1.5% salt had SGR

Table 2: Growth performance of gilthead sea bream reared in different water salinities for 140 days and fed different salt rich diets

System	Water salinity (ppt)	Tank no.	Types of feed	Average initial weight (g)	Average final weight (g) ± SD	Survival (%)	SGR (%)
1	3	1	Diet 1 (Control)	0.4	17.31 ±2.49^{a}	37.8	2.68^{a}
		2	Diet 2 (0.5% salt)	0.4	19.91± 2.06^{ab}	42.1	2.78^{ab}
		3	Diet 3 (1.5% salt)	0.4	22.20± 2.55^{b}	35.7	2.86^{b}
2	5.5	1	Diet 1 (Control)	0.4	20.30± 4.71	41.2	2.80
		2	Diet 2 (0.5% salt)	0.4	21.54± 4.20	47.7	2.83
		3	Diet 3 (1.5% salt)	0.4	24.06± 5.0	48.9	2.92
3	7	1	Diet 1 (Control)	0.4	21.51± 4.61	43.4	2.83
		2	Diet 2 (0.5% salt)	0.4	24.50± 6.35	50.7	2.92
		3	Diet 3 (1.5% salt)	0.4	24.33± 6.36	49.3	2.92

significantly higher than those fed the control diets. The average survival rate of the fish reared in 3.0 ppt salinity was only 38.53% while the highest average survival rate of 47.8% was attained in fish reared in 7.0 ppt salinity.

From the results of this present experiment, it is evident that long-term exposure of sea bream to low salinity (3.0 ppt) water resulted in growth reduction and low survival rate. The lower the salinity of the test rearing water, the lower was the survival rate. However, the diet containing the highest level of salt (1.5%) could improve the fish growth significantly when reared at lower rearing salinity (3.0 ppt). The results have also indicated that the effect of the salt-enriched diet on the sea bream was more pronounced in the lower salinity water in which the fish were reared. Adding 1.5% sea salt to the diet makes it possible for the fish to grow in water with the lowest tested salinity of 3.0 ppt as well as in highest tested salinity of 7.0 ppt.

Conclusion

From this experiment, it was shown that the use of low salinity water (a mix of brackish water and sea salt) for rearing sea bream resulted in the reduction of growth and increase in mortalities. The experiment indicated that the lower the salinity of the mixed water, the more pronounced was the effect on growth and survival. However, the addition of sea salt to the feed improved the growth and survival rates. The lower the salinity of the rearing water the more effective was the salt-enriched diet on the growth performance. Thus, the findings from this experiment promotes the prospects of euryhaline fish culture in low water salinity opening up a promising future for marine fish production in regions where low saline geothermal water of high quality is available.

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The Bengis Centre for Desert Aquaculture, Albert Katz Department of Dryland Biotechnologies, Jacob Blaustein Institute for Desert Research, Ben-Gurion University of the Negev, Israel is gratefully acknowledged for providing a postdoctoral fellowship grant to the second author, A. Jesu Arockia Raj. The authors also extend their special thanks to Mr. David Benzion and Mr. Alan Wass for their technical help in preparing this article.

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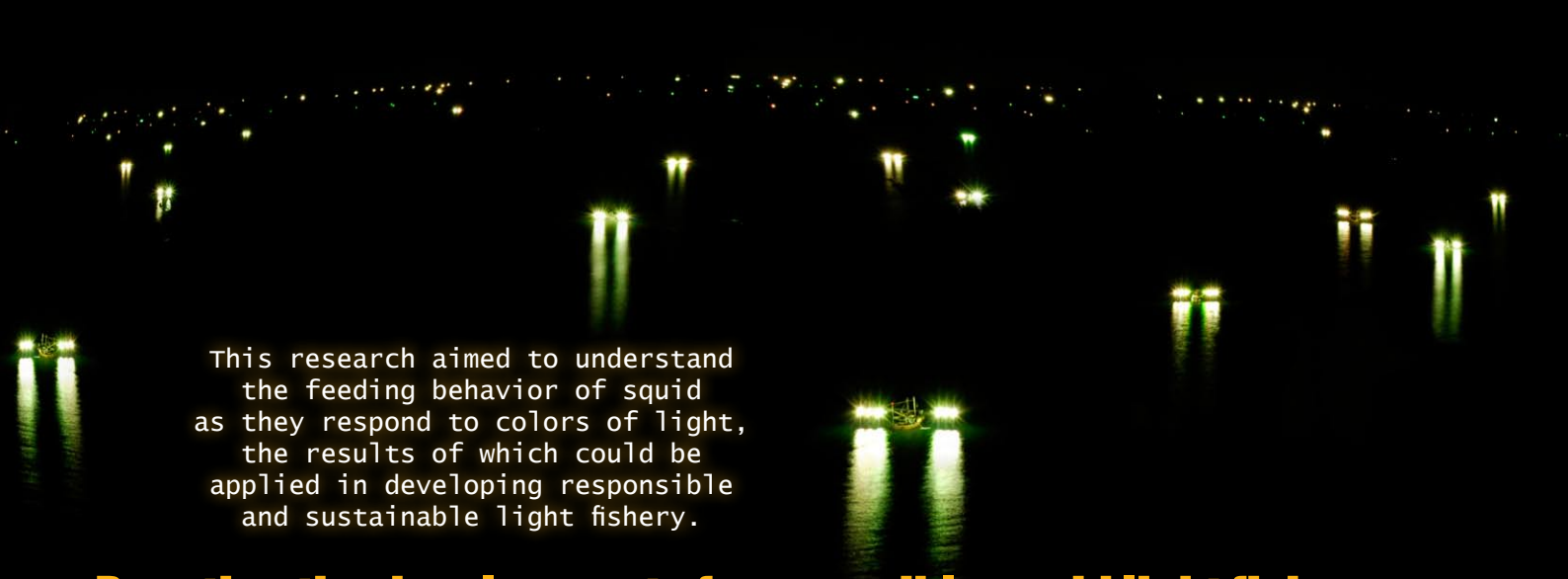

This research aimed to understand the feeding behavior of squid as they respond to colors of light, the results of which could be applied in developing responsible and sustainable light fishery.

Boosting the development of responsible squid light fishery: Assessment of squid feeding behavior

Sukchai Arnupapboon, Kamonpan Awaiwanont, Monton Anongponyoskun, Suphachai Annanpongsuk and Bundit Chokesanguan

The experiment using colors of light to monitor the feeding behavior of squid was conducted at the Eastern Marine Fisheries Research and Development Center in Ban Phea, Muang District, Rayong Province, Thailand. A dark room was constructed to accommodate a concrete tank (5 m in diameter). Five (5) channels of black plastic strips (40x125x70 cm each) were set at the inner part of the concrete tank. Five (5) black plastic pipes (6 cm in diameter and 86.5 cm in length) were hung above the first four (4) channels while the last channel served as the control (dark). A lamp was attached at the tip end of each pipe about 135 cm above the water surface (water level: 27 cm). Four color lights (white, blue, green and red) were generated by LED lamps (0.5 cm in diameter with a power supply of 12v 5mA). Each channel had a small aquarium (15x15x30 cm) with live fish baits to stimulate the squid to pass and enter the channel. A total of 44 squids were used in the experiment which was conducted at night time. The positions of the color light source were rotated for 10 batches with 8 replicates each. For each replicate, the number of squid entering each channel was counted. The results showed that the number of squids entering the 5 channels were significantly different ($P \leq 0.05$). The sequence of color lights preferred was: white, blue, green, red and control, respectively. White and blue were not different ($P \geq 0.05$), but white color was significantly more attractive than the green, red and the control ($P \leq 0.05$). Blue was significantly more attractive than the green, red and control ($P \leq 0.05$) and green was significantly more attractive than the red and control ($P \leq 0.05$). Red and the control were not different ($P \geq 0.05$).

Squid's Attraction to Different Colored Lights

Squids (*Loligo dauvauceli* and *L. chainensis*) are among the most economical marine resources and play significant role in Thailand's fish trade. The demand for squid is increasing for domestic consumption as well as for export. The rapid development of squid fisheries in Thailand occurred since trawl fishery was introduced. Presently, with more widespread use of luring lamps for attracting squid, falling nets and lift nets have increasingly been employed without any due consideration to the theatrical aspects of attraction. In 1995, there were 1894 squid falling net vessels in Thailand and this number increased to 3160 vessels in 2004 (http://www.fisheries.go.th/it%2Dstat/).

Unfortunately, even if these gears are able to increase squid production, such gears can damage the marine resources by capturing also the under-marketable sizes of aquatic animals.

Attracting to a light source is a common reaction among aquatic species, a behavior which is true not only in squids but also in other species such as the spotted mackerel (*Pneumatophorus tapeinocephalus*), sardines (*Sardinops melanostictus*), Japanese anchovy (*Engraulis japonica*), Japanese parrotfish (*Opleganathus fasciatus*), bluegill (*Lepomis macrochirus*) (Kawamura, 1986), grey mullet (*Mugil cephalus*), gilthead seabream (*Sparus auratus*), striped bream (*Lithognathus mormyrus*) (Marchesan et al. 2005), and Japanese anchovy and sardines (Awaiwanont et al., 2001).

Many studies have been conducted to determine the physiological and cellular levels of such behavior, including some works on assessing the role of visual sense to spectral sensitivity particularly the micro-electrode technique, spectral adsorption and behavior response. Results from such studies indicated that even though most marine aquatic animals can perceive light spectrum in the range of 400 to 750 nm, different species have different considerable scales of spectral sensitivities. For instance, the maximum spectrum sensitivity of the north anchovy (*Engraulis mordax*) is 530 nm (Bagarinao and Hunter, 1983), 482 nm for the sand lance (*Ammodytes hexapterus*) (Britt et al., 2001), 460-525 nm for the European sea bass (*Dicentrarchus labrax*) and 410-460 nm for grey mullet (*Mugil cephalus*) (Marchesan et al., 2004). However, if the preferred color (light spectrum) for squid could be determined, the results would provide useful information for improving the fishing technique for squid not only increasing catch efficiency but also reducing the problem of by-catch mortality. Therefore, this study was conducted to investigate the effect of variable light color design in the feeding behavior of the squid and also to obtain useful information for developing selective light fishing techniques for responsible and sustainable light fishery.

Observation of Squid Behavior

Squid specimens were collected by set net fishery in the morning of January 2007 at Had Maelampioen, Rayong Province, and were transferred to a 5 m diameter concrete test tank at the Eastern Marine Fisheries Research and Development Center (EMDEC), Banpae, Muang District, Rayong Province.

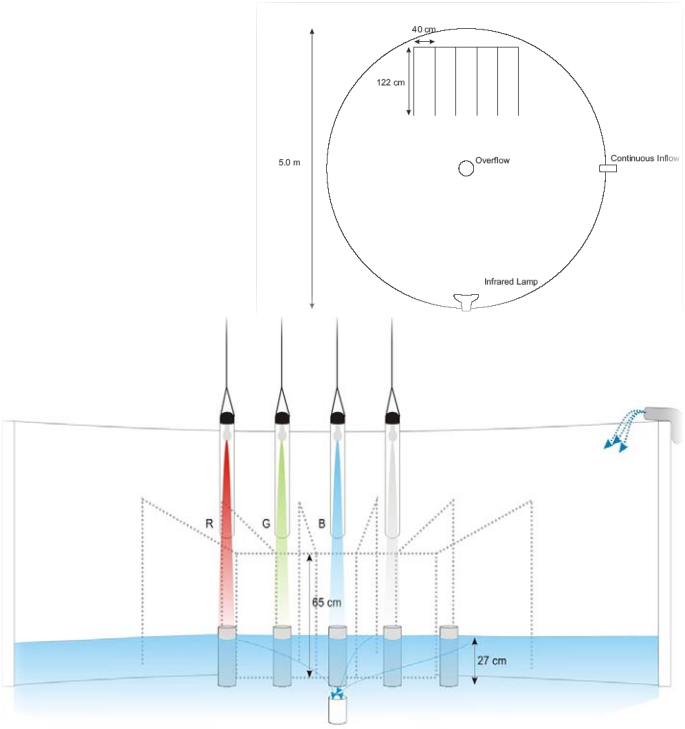

Fig. 1. Experimental setup: top view (top) and side view (above)

The experiment was performed at night time with 44 squids (32 individuals of *Loligo duvauceli* with 9.75±2.29 cm mantle length and 34.55±21.41 g weight and 12 individuals of *L. chainensis* with 8.50±2.70 cm mantle length and 29.53±19.21 g weight). The depth of the water was 27 cm with continuous overflow to keep the squid alive. The tank was covered with black canvas serving as a temporary dark room to avoid the effects from the moonlight. Inside the tank, five (5) channels of black plastic fence (40x122x65 cm each channel) were constructed (Fig. 1). The sources of lights were the infrared lamp and Light-Emitting Diode (LED) lamps where the infrared lamp was mounted inside the room at the rim of the concrete tank opposite the entrance of the channels. In order to determine the spectral sensitivity, four (4) colors of the LED lamps (red, green, blue and white) were used as luring lamp, which were separately hung above each channel while the remaining channel served as the control (dark). The LED lamps were mounted about 135 cm above the water surface. Light beams were separated from each other by means of black plastic pipes (6.0 cm in diameter and 86.5 cm in length). Each LED lamp was 0.5 cm in diameter with 12v 5mA power supply. Small aquaria (15x15x30 cm each) with live fish baits inside were placed under the lighted areas to stimulate the squids to pass and enter the channels.

At the start of the experiment, the four (4) luring lights and infrared lamp were turned on for about 30 minutes for acclimatization. The infrared lamp was then turned off for 1 minute then turned on again to count the number of squids entering each channel. The turning on and off of the infrared lamp was conducted for 8 replicates per batch before the light position is rotated. The rotation of the light position was done for 10 batches to eliminate possible effects of both the light position and the channel (**Table 1**). The number of squids occupying the five (5) channels was compared by ANOVA ($P \leq 0.05$). The statistical differences were analyzed using the LSD test (Pongwichai, 1997).

Squid Behavior in the Tank

The squids were acclimatized for at least 12 hours in the test tank before the experiment, and no feeding was done to stimulate feeding behavior. The experiment started at 2100 h with both infrared and LED lamps turned on. The test squids showed an interesting behavior where they aggregated opposite the entrance of the five (5) channels and remained motionless but staring at the baits. Some squids swam slowly either clockwise or counter-clockwise with their mantle along the tank wall. While moving towards the entrance of the channels, their movement was rather slow but looking towards the baits. The squids appeared to be afraid to go inside the channels, leaving the channel entrance and swimming around the tank again. There were moments

Table 1. Rotation of light positions and number of replicates per batch

Number of batch	Channel of light position					Total replicates
	1	2	3	4	5	
1	Red	Green	Blue	White	Control	8
2	Green	Blue	White	Control	Red	8
3	Blue	White	Control	Red	Green	8
4	White	Control	Red	Green	Blue	8
5	Control	Red	Green	Blue	White	8
6	White	Red	Control	Blue	Green	8
7	Red	Control	Blue	Green	White	8
8	Control	Blue	Green	White	Red	8
9	Blue	Green	White	Red	Control	8
10	Green	White	Red	Control	Blue	8

when the squids showed jet-like propulsion behavior swimming near the black plastic fences. When the infrared lamp was turned off while the LED lamps were still on, most squids were swimming fast to the entrance of the channels without hesitation and swimming towards the lighted areas and the baits. The squid tried to catch the baits for a while before swimming out of the channels to the dimmed areas and swimming again back for the baits. When the infrared lamp was turned on, the squids inside the channels instantly moved out from the channels showing the same behavior as before the infrared lamp was turned off.

Color Attraction by the Squid

The results of the study indicated the sequence of the preferred colors by the squid, i.e. white, blue, green, red, and control, at 327, 285, 151, 18, and 9 individuals, respectively. The means of squids occupying per batch of the white, blue, green, red colors and the control were 1.80, 15.10, 28.50, 32.70 and 0.90 individuals, respectively (**Table 2**).

Table 2 shows that the number of squids entering the five (5) channels was significantly different ($P \leq 0.05$). The number in the white and blue colors was not different ($P \geq 0.05$). The number in the white color was significantly different from those in the green, red colors and control ($P \leq 0.05$). The number in the blue color was significantly different from those in the green, red colors and control ($P \leq 0.05$). The number in the green color was significantly different from those in the red color and the control ($P \leq 0.05$) while those in the red color and the control were not different ($P \geq 0.05$).

There are about 700 species of cephalopods living between the tides, in the deep ocean, and in the surface waters throughout the seas of the world (Hanlon and Messenger, 1996). Cephalopods are invertebrates which can be classified under Mollusca but many features of their behavior are more in common with fishes than with other invertebrates (Hanlon and Messenger, 1996). They have highly developed sense organs and complex behavior (Abbott et al., 1995; Hanlon and Messenger, 1996). However, most cephalopods have only one visual pigment and are completely color blind (Hanlon and Messenger, 1996; Shashar and Cronin, 1996). Only the mid-water firefly squid (*Watasenia scintillans*) can see colors because they have three visual pigments (Seidou et al., 1990). The color blind squids can see only the differences in polarized lights but can also create patterns using these differences on their bodies (Shashar and Cronin, 1996; Shashar et al., 1996).

Conclusion

This experiment evaluated the behavioral attraction to colored lights preferred by *L. dauvauceli* and *L. chainensis* which have no reported record of being color blind. The two species were considered because these are the target

Table 2 Batch and number of squids occupying each channel of light colors

Light color	Number of squid per batch										Total	Avg.
	1	2	3	4	5	6	7	8	9	10		
Red	1	1	1	3	2	3	5	0	1	1	18	1.80
Green	3	17	18	28	17	13	12	11	23	9	151	15.10
Blue	10	33	25	33	47	31	33	27	28	18	285	28.50
White	13	10	28	50	41	26	35	55	28	41	327	32.70
Control	0	2	1	3	1	0	0	0	1	1	9	0.90

Table 3. Diffuse attenuation of light wavelengths

Wavelength (nm)	Diffuse attenuation
400	0.017
450	0.015
500	0.026
550	0.064
600	0.244
650	0.349
700	0.650

species for the development of squid capture technique using colored lights. From the results of this experiment, the different number of squids entering the five (5) channels indicated their reactions to different colors. The squid were observed to be swimming forward to both white and blue more often than the green, red and control while the red color and the control seemed not to attract the squids. Thus, it could be concluded that the squid was strongly attracted to blue and white colors but could not perceive the red color.

Light attraction behavior importantly depends on the physical characteristic of lights, especially their wavelengths (Marchesan et al., 2004). Based on the characteristics of the LED lamp produced by Toyoda, the maximum wavelengths emitted by LED red, green, blue and white are 620-625 nm, 520-530 nm, 465-475 nm and 465-475 nm, respectively (http://www.toyoda-gosei.com/led/). This showed that blue and white emitted the necessary color spectrum although light attraction was reduced in green and red, respectively. Thus, squids could be attracted to the blue light. In nature, blue light can penetrate and transmit blue color into the deeper seawater than the other lights (**Table 3**). A summary of diffuse attenuation in seawater between 400 to 700 nm showed that the blue light (wavelength: 440-490 nm) penetrates deeper and farther than the other colors and the red light (wavelength: 630-670) can be extinguished even in not so deep waters by the scattering and absorption phenomena (Smith and Baker, 1981) in (Arimoto, et al., 2001). Jerlov (1968) explained that the maximum spectral distribution is shifted towards the longer wavelength in turbid areas because of selective absorption by particles and the yellow substance.

Knowledge on the preferred colors of light by squid and on the diffuse attenuation of color lights are fundamental tools for developing potential methods of selective fishing. This could enhance catch efficiency and reduce by-catch mortality especially when using appropriate luring lamps that emit monospectrum or monocolor. The color of the light that attracted the squid most in this experiment was blue. Squids can see their baits more clearly when illuminated with blue light than with the other colors.

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CALENDAR OF EVENTS

Date	Venue	Title	Organizer
		2008	
16-18 January	Bangkok, Thailand	ASEAN-SEAFDEC Workshop on Implementation of ASEAN Roadmap for Integration of Fisheries Sector	DOF Thailand & SEAFDEC Secretariat
4-8 February	Rome, Italy	Technical Consultation on International Guidelines for the Management of Deep-Sea Fisheries in the High Seas	FAO
12-14 February	Chiangmai, Thailand	ASEAN-SEAFDEC Regional Technical Consultation (RTC) on International Fisheries-related Issues (2008)	SEAFDEC Secretariat
24-27 March	Bangkok, Thailand	1st ASEAN-SEAFDEC RTC on Promotion of "One Villabe One Fisheries Product (FOVOP)" in ASEAN Region	SEAFDEC Secretariat
31 Mar-4 Apr	Bangkok, Thailand	FAO/APFIC/SEAFDEC Regional Workshop on Port State Measures to Combat IUU Fishing	FAO/APFIC/SEAFDEC
8-10 April	Bangkok, Thailand	Fishery Conservation and Management Workshop for Young Generation	SEAFDEC/TD
7-25 April	Philippines	Training Course on Grouper Hatchery for the Philippines	AQD, NACA, ACIAR
8-22 April	Thailand	Regional Training Course on Set-Net Fishing Technology for Sustainable Coastal Fisheries Management	SEAFDEC/TD
29 Apr-2 May	Bangkok, Thailand	ASEAN-SEAFDEC RTC on Small-scale Fisheries in Southeast Asia	SEAFDEC Secretariat
30 Apr-4 May	Philippines	Training Course on Mangrove Ecology, Taxonomy and Community Structure	SEAFDEC/AQD, RESCOPAR
5-8 May	Beijing, China	6th Meeting of ASEAN Expert Group on CITES (AEG-CITES)	ASEAN
5-9 May	Philippines	Training Course on Seaweed (Kappaphycus) Farming	AQD, WWF-Philippines
6-15 May	Bangkok, Thailand	International Training Course on Coastal Fisheries Management for Fishery Managers	SEAFDEC/TD
7-27 May	Philippines	Training Course on Abalone Hatchery and Grow-out	SEAFDEC/AQD
11-25 May	Philippines	Shipboard Training Workshop on the Deep Sea Fishery Resource Exploration of the Continental Shelf Slopes in Southeast Asian Waters	SEAFDEC/TD, Philippine BFAR
19-23 May 2008	Islamabad, Pakistan	29th FAO Regional Conference for Asia and the Pacific	FAO
20 May-25 Jun	Philippines	Training Course on Marine Fish Hatchery	SEAFDEC/AQD
21-23 May	Bangkok, Thailand	16th Meeting of the ASEAN Sectoral Working Group on Fisheries	ASEAN
26 May-15 Jun	Bangkok, Thailand	Advance Training Workshop on Larval Fish Identification and Fish Early Life History Science	TD, UNEP/GEF/SCS
2-6 June	Bremen, Germany	11th Session of FAO Sub-Committee on Fish Trade	FAO/COFI
10 Jun-1 Jul	Philippines	Training Course on Crab Seed Production	SEAFDEC/AQD
17-19 June	Bangkok, Thailand	Workshop on Assessment and Management of the Offshore Resource of South and Southeast Asia	SEAFDEC/TD, FAO
23-27 June	Bangkok, Thailand	Fishing Vessel Operation Training Course	SEAFDEC/TD
23-27 June	Rome, Italy	Technical Consultation to draft a legally-binding instrument on port State measures to prevent, deter and eliminate illegal, unreported and unregulated fishing	FAO
30 Jun-2Jul	Phuket, Thailand	Expert Meeting on Vessel Registration	SEAFDEC Secretariat
3-5 July	to be determined	RTC on HRD on Poverty Alleviation and Food Security by Fisheries Intervention in the ASEAN Region	SEAFDEC Secretariat
28-31 July (tentative)	to be determined	Regional Workshop for Capacity Building on Fishery Statsitics in Southeast Asia (Framework and Streamlined Reporting)	SEAFDEC Secretariat
Jul-Nov (tentative)	Distance learning	Distance Learning: Principles of Health Management in Aquaculture	SEAFDEC/AQD
18-22 August (tentative)	to be determined	Regional HRD Workshop on Identification of Potentials and Problem Areas for the Promotion of "FOVOP" in the ASEAN Region	SEAFDEC Secretariat
1-15 September (tentative)	Lao PDR	2nd Joint Regional Training on Comunity-based Aquculture for Remote Rural Areas of Southeast Asia	SEAFDEC Secretariat
6-10 October	Puerto Varas, Chile	4th Session of FAO Sub-Committee on Aquaculture	FAO
13-17 October 2008	Bangkok, Thailand	Global Conference on Small-Scale Fisheries	FAO, DOF Thailand

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.

Objectives
SEAFDEC aims specifically to develop fishery potentials in the region through training, research and information services in order to improve food supply through rational utilization of fisheries resources in the region.

Functions
To achieve its objectives the Center has the following functions:
1. To offer training courses, and to organize workshops and seminars, in fishing technology, marine engineering, extension methodology, post-harvest technology, and aquaculture;
2. To conduct research and development in fishing gear technology, fishing ground surveys, post-harvest technology and aquaculture, to examine problems related to the handling of fish at sea and quality control, and to undertake studies on the fisheries resources in the region; and
3. To arrange for the transfer of technology to the countries in the region and to make available the printed and non-printed media, which include the publication of statistical bulletins for the exchange and dissemination related to fisheries and aquaculture development.

Membership
SEAFDEC members are the ASEAN Member Countries (Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam) and Japan.

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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 second best drawing from Singapore.