FISH for the PEOPLE

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SEAFDEC at 50:

Strengthening collaboration for sustainable management of fishery resources in Southeast Asia

Southeast Asian Fisheries Development Center

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Editorial

The Celebration of the 50th Anniversary of SEAFDEC on 15 November 2017 depicted the feat and achievements of SEAFDEC during the past fifty years and its desires for the years beyond, in revolutionizing the sustainable fisheries development of Southeast Asia. The Celebration displays not only its past achievements, but also the continued unwavering commitment of SEAFDEC and all the Member Countries in working together to ensure that the fisheries sector would continue to provide sustainable contribution to food security and well-being of the peoples in the Southeast Asian region. SEAFDEC would therefore continue to promote sustainable development and management of the region's fisheries in the years ahead.

As part of its continuing efforts towards the sustainable development and management of the region's fisheries, SEAFDEC would also be ensuring that transboundary fish stocks are well-managed. The Southeast Asian region is endowed with fishery resources that are characterized as being transboundary and comprise a wide range of highly migratory fish species that are shared by many countries making management of the fisheries of such species by only one country almost impossible. The high variability in stock abundance coupled with the migratory behavior of many economically-important pelagic fishes pose a great challenge in the sustainable development and management of their fisheries. Stocks of some pelagic species which are being shared by many countries in the region should therefore be sustainably managed to avoid overexploitation which could eventually lead to decline or even total collapse of the stocks. Addressing these issues has been taken as a top priority in the planning of SEAFDEC programs considering that the sustainability of these fishery resources would ensure food security and improved livelihoods of peoples in the

Southeast Asian region. As human population and demand for fish continue to rise, there is a need to address these issues through the development of integrated management measures. However, aside from the migratory nature of the fish stocks, there are also other factors that could impede the sustainable management of fisheries in the Southeast Asian region that need to be settled among the concerned countries. These could include fishing licenses provided to foreign fishing vessels, unregulated nature of domestic fisheries, fisheries being small-scale in nature, high regional mobility of fishing crew, and the continued practice of illegal, unreported and unregulated (IUU) fishing which has now been getting much attention.

Recognizing that management of shared stocks is fundamental for sustainable fisheries management, SEAFDEC has therefore considered the establishment of appropriate regional and sub-regional fisheries management mechanisms for Southeast Asia. In order to achieve this, it is also crucial that information on stock identification and shared stocks of pelagic fishes are made available as these are necessary in promoting sustainable management of the fisheries of these resources. Through the SEAFDEC-Sweden Project, SEAFDEC has been addressing these concerns since early 2000s by initiating actions towards the establishment of sub-regional cooperation for fisheries management, with the areas under focus that include the Gulf of Thailand, Andaman Sea, Lower Mekong River Basin, and Sulu-Sulawesi Seas, and where relevant activities are being undertaken by SEAFDEC in close collaboration with other organizations working on fisheries development in the particular areas. This endeavor is part and parcel of the continuing journey of SEAFDEC beyond its 50th Anniversary, towards the sustainable development and management of fisheries in the Southeast Asian region.

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CONTENTS

Special Feature

- Towards the Sustainability of Southeast Asian Fisheries: the role of SEAFDEC during the past 50 years and beyond 2

Regional and Sub-regional Initiatives

- Building upon Sub-regional Arrangements for Joint Management of Fishery Resources in the Southeast Asian Region 7
- Sustainable Management of Neritic Tunas in Southeast Asia: longtail tuna and kawakawa in focus 14
- Going on a high note: the SEAFDEC Information Programs 21

Country Report

- Sustainable Management of Inland Capture Fisheries for Food Security: experience of Indonesia 28

Special Report

- The Shifting Habitat of Hilsa: from river to sea 36

Calendar of Events 40

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.

Towards the Sustainability of Southeast Asian Fisheries: the role of SEAFDEC during the past 50 years and beyond

Deb Menasveta

This article is based on the Keynote Address delivered by the Author during the Celebration of the 50th Anniversary of SEAFDEC at Dusit Thani Hotel in Bangkok, Thailand on 15 November 2017, which recounts the developmental efforts of SEAFDEC during its first 50 years and provides suggestions for the enhancement of SEAFDEC's tasks in the years to come. The Author started the Keynote Address by paying tribute to two regional projects that have had profound impact on the accelerated development and rational utilization of fishery resources and on the thinking of fisheries administrators of Southeast Asia. These are the FAO/UNDP South China Sea Fisheries Development and Coordinating Programme from 1973 to 1984 and the Southeast Asian Fisheries Development Center from 1967 to the present.

Introduction

The development of the proposal for Phase I of the South China Sea Fisheries Development and Coordinating Programme as a regional project for possible support from the United Nations Development Program (UNDP), was based on the recommendation of the late *Dr. John C. Marr* of the United States, who was then the Program Manager of the FAO/UNDP Indian Ocean Program. Dr. Marr was well known to the Southeast Asian fisheries administrators because of his remarkable knowledge about the fishery resources and the fisheries management needs of the Southeast Asian countries. Based on the said proposal, the Project was subsequently supported by the UNDP and remained in operation until 1984, yielding significant contributions to the acceleration of fisheries development of Southeast Asia with technical inputs estimated by the post project evaluation mission, to be more than 200 million US dollars. The South China Sea Fisheries Development and Coordinating Programme also served for many years during its life span, as the technical arm of the Indo-Pacific Fishery Commission (IPFC).

As for SEAFDEC, the proposal for the establishment of a training center for fishermen with possible support from the Government of Japan, submitted during the First Ministerial Conference for Economic Development of Southeast Asia in Tokyo in April 1966, was developed through the efforts of the late *Dr. Prida Karnasut,* the Director-General for Fisheries of Thailand at that time. During the said Conference, the delegates expressed interest in having such a training center, while the Government of Japan had agreed in principle to support a regional fisheries center for the promotion of fisheries development in Southeast Asia.

As a consequence, two sessions of a working party which included the Author as one of the members, were convened to formulate an Agreement establishing the Southeast Asian Fisheries Development Center (SEAFDEC), which was approved during the Inaugural Session of the Council of SEAFDEC in Bangkok in 1968. Moreover, there are other bodies and arrangements that play crucial role in the accelerated development and management of fisheries in Southeast Asia. These include the Food and Agriculture Organization (FAO) of the United Nations, Asia-Pacific Economic Cooperation (APEC), Association of Southeast Asian Nations (ASEAN), Indo-Pacific Fishery Commission (IPFC), Intergovernmental Organization for Marketing Information and Technical Advisory Services for Fishery Products in the Asian and Pacific Region (INFOFISH), Mekong River Commission; Network of Aquaculture Centres in Asia and the Pacific (NACA), and the WorldFish Center. SEAFDEC has been collaborating with these organizations and arrangements to foster good governance in the rational utilization of fishery resources in Southeast Asia.

Former SEAFDEC Secretary-General *Dr. Deb Menasveta* delivering the Keynote Address during the Celebration of the 50th Anniversary of SEAFDEC on 15 November 2017

Evolution of SEAFDEC with the Dynamic Changes in World Fisheries

Hunger was the main issue after World War II. This was the major reason for the establishment of the Food and Agriculture

Organization (FAO) of the United Nations in 1945, with the main objective of eliminating world hunger and malnutrition. Recognizing the valuable contribution of protein food from the world oceans and freshwater sources, FAO established the Indo-Pacific Fisheries Council (now Indo-Pacific Fishery Commission) under Article 14 of its constitution in 1948 to help increase the food supply from the oceans. This was the first regional fishery body of FAO which contributed to the modernization and growth of the fishing industry and fisheries development of Southeast Asia. Two decades later, many countries together with the Southeast Asian countries still anticipated that more fishery resources especially off their coastal waters could be exploited to feed their expanding populations.

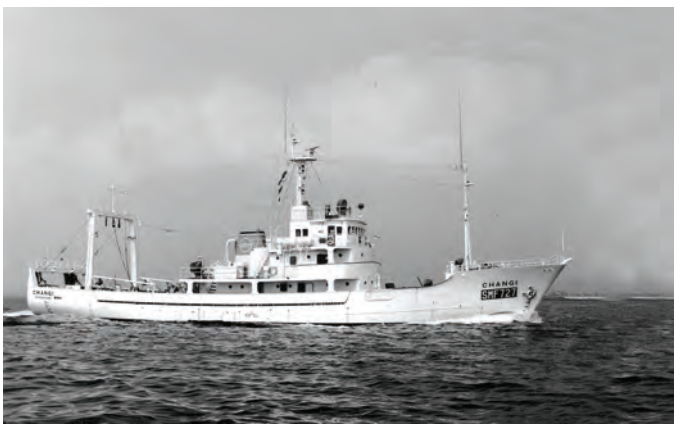
The evolution of SEAFDEC from its humble beginnings in 1967 with the primary concern of fish production increase was definitely in consonance with the world thinking. Since then SEAFDEC also known as the Center, has evolved along with the changes which have taken place in world fisheries. When it was established, the Center had two technical departments, viz., the Training Department (TD) hosted by the Government of Thailand and the Marine Fisheries Research Department (MFRD) hosted by the Government of Singapore. In response to the Center's broad mandate of promoting fisheries development for Southeast Asia, the main concern of these two technical departments was to modernize the fishing industry of the Member Countries by training master fishermen and marine engineers to man commercial or semi-commercial fishing enterprises, and to locate unexploited fishing grounds in our large Sunda Shelf and its contiguous waters. In 1973 the Government of the Republic of the Philippines agreed to host the Aquaculture Department within the established mandate of the Center with the aim of increasing production of fish from aquaculture.

Sunda Shelf is a southeast extension of the continental shelf of Southeast Asia, where the major landmasses include the Malay Peninsula, Sumatra, Borneo, Java, Madura, Bali and their surrounding smaller islands. The Shelf covers an area of approximately 1.85 million km^2. The sea depths over the Shelf rarely exceed 50 meters and extensive areas are less than 20 meters resulting in strong bottom friction and strong tidal friction. Steep undersea gradients separate the Sunda Shelf from the Philippines, Sulawesi, and the Lesser Sunda Islands.

Source: https://en.wikipedia.org/wiki/Sunda_Shelf

In the second half of the seventies, an international management study group headed by *Mr. Roy Jackson*, then the Assistant Director-General of FAO in charge of fisheries assisted SEAFDEC in appraising its structure and functions as well as its Financial and Administrative Regulations with a view to strengthening them. Funded by the US Agency for International Development (USAID), the study group not only made a series of recommendations, notably, the revision of the said Regulations, but also raised questions about the future of SEAFDEC. Their view was that the South China Sea Fisheries Development and Coordinating Programme had been doing well in assisting the Southeast Asian countries in the development and management of their fishery resources. Furthermore, the International Center for Living Aquatic Resource Management (ICLARM), now referred to as the WorldFish Center, would soon be established under the umbrella of the Consultative Group on International Agricultural Research (CGIAR) which could render assistance to the Southeast Asian countries to develop and manage their fishery resources. However, the SEAFDEC Council of Directors during its Twelfth Meeting in 1979 was resolute and unanimously agreed that SEAFDEC had to continue to function.

In 1974, with the unavailability of the M.V. CHANGI, MFRD was tasked to take up post-harvest technology development while their works on the survey of fishing grounds transferred to TD. With this change of the situation, the Center commenced to broaden its scope of work to include the compilation and establishment of the regional fishery statistical and information systems to ascertain the state of the stocks of fish being exploited.



The M.V. CHANGI granted by the Government of Japan to MFRD in 1969 was decommissioned in 1974

Fisheries post-harvest technologies developed by MFRD are transferred to the Southeast Asian countries through human resource development

In 1981, SEAFDEC sought funding support from the International Development Research Centre (IDRC) of Canada, for the setting up of a fishery information and database. Meanwhile, shorter fishery training courses were arranged with the additional financial support from the Government of the Netherlands. Arrangements were also made with the FAO/UNDP South China Sea Fisheries Development and Coordinating Programme to jointly organize a training course on fishery stock assessment in 1982. The Center also collaborated with its Member Governments and FAO, through sessions of working parties to build up a statistical data base. As a result, the first issue of the Fishery Statistical Bulletin for the South China Sea Area of 1976 was published in 1978.

In the eighties, a significant change in world fisheries took place when the 1982 United Nations Convention on the Law of the Sea (UNCLOS) enabled coastal and archipelagic states to acquire rights and opportunities to develop and manage the fishery resources in their respective exclusive economic zones up to 200 miles from the base line. With the accelerated development of world fisheries during this period, it was generally agreed that more than 70 percent of marine fishery resources of the world had been fully exploited. FAO took the initiative in the implementation of the UNCLOS by organizing a World Conference on Fisheries Management and Development in June-July 1984. The Conference had drawn up a set of strategies and programs of action to assist the world community in the conservation and rational utilization of fishery resources.

In the beginning of the eighties, good progress was made with the setting up of the Center's information services and systems with the funds provided by IDRC. The small-scale fishing and fish farming stakeholders from the region have benefited by receiving information handbooks on fishing and fish farming transcribed into the local languages of the Southeast Asian region. Progress was also made on the setting up of national and regional bibliographies on fisheries and aquaculture by this project. However, at the end of the IDRC assistance in 1989, the information-related works of the Center had been scaled down because of the lack of funding support.

SEAFDEC through its technical departments gradually modified the long-term training courses to shorter ones. For example, the two-year training for master fishermen and marine engineers to man semi-commercial or commercial fishing vessels, was transformed into shorter courses to be able to train more small-scale fishermen, also with financial support from the Government of the Netherlands. Likewise, knowledge of simple aquaculture techniques has been provided to small-scale fish farmers.

In the field of post-harvest technology development, training courses were organized to familiarize the stakeholders with the Codex Alimentarius and other regulations pertaining to the enhancement of the quality and safety of fishery products both for domestic consumption and export. In 1990, the SEAFDEC Marine Fishery Resources Development and Management Department (MFRDMD) was established and hosted by the Government of Malaysia. Thus, the scope of work of the Center had become broader.

In 1992, the United Nations convened the Conference on Sustainable Development or Earth Summit 1992, which provided inter alia under its Agenda 21 a conceptual framework for the world community to plan and implement policies and strategies for the rational use and development of living resources in the oceans, seas and coastal waters. A follow up convention was convened in 2012, the Earth Summit 2012. As an outcome of the 1992 Earth Summit and in the implementation of the 1982 UNCLOS, a number of initiatives and legal instruments for the sustainable development of the fishery resources were created. Among others, were the United Nations Fish Stocks Agreement of 1995; FAO Code of Conduct for Responsible Fisheries 1995; FAO International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing; and the FAO Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing.

SEAFDEC has responded quickly to the policies and strategies set forth by the world community to enhance good fishery governance and responsible utilization of fishery resources. It has successfully developed a series of Regional Guidelines for Responsible Fisheries in Southeast Asia for the effective implementation of the FAO Code of Conduct for Responsible Fisheries in the region. It has also facilitated the better understanding of the implications of the global plans of action and instruments planned to be implemented in the region.

In 2001, the Center, in collaboration with the Association of Southeast Asian Nations (ASEAN) and other international and regional fishery organizations, successfully organized

the Millennium Conference: "Fish for the People". Arising from this Conference was a special five-year program to achieve sustainable fisheries for food security in the region. Subsequently, a follow-up ASEAN-SEAFDEC Conference "Fish for the People 2020": Adaptation to a Changing Environment was convened in 2011. It also produced a set of guidelines for the next decade to achieve fisheries sustainability for food security and the improvement of the livelihood in the region.

In addition to Japan and with all ten Southeast Asian nations as members of SEAFDEC since 2003, the Center has become a full-fledged and internationally recognized intergovernmental institution responsible for sustainable fisheries development. Its mandate, as recommended by the Third SEAFDEC Management Review Committee, is "*to promote concerted efforts among the Member Countries to ensure the sustainable contribution of fisheries and aquaculture to the economies, social well-being and food security of the countries of Southeast Asia*".

The Third SEAFDEC Management Review Committee Members (2012-2013)

With all Member States of the ASEAN as members of SEAFDEC, the relationship between ASEAN and SEAFDEC has been fostered, and was formalized with the signing of the ASEAN-SEAFDEC Strategic Partnership in 2007. Through such arrangements, SEAFDEC has been recognized as the technical arm for the implementation of fisheries projects for the ASEAN.

The latest part of the historical events of SEAFDEC during the past ten decades was the establishment in 2014 of the SEAFDEC Inland Fishery Resources Development and Management Department hosted by the Government of Indonesia, to work on the sustainable development of inland capture fisheries. With this recent development, all the Technical Departments of SEAFDEC truly serve the original objective of the Center, which was to respond to the needs and eliminate hunger and malnutrition in the Southeast Asian region.

The Future of SEAFDEC

The ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security in the New Millennium in 2001 and the follow-up ASEAN-SEAFDEC Conference held in 2011 with emphasis on the adaptation to a changing environment have set good guidelines for the future work of the Center in the twenty-first century. However, there are still issues that need further consideration.

These could include:

1. The sustainable development and management of small-scale fisheries in the Member Countries of SEAFDEC with in-depth consideration of coastal area management and the use of an ecosystem approach in the management of fishery resources
2. Issues relevant to the trans-boundary fish stocks or shared stocks on the Sunda Shelf, with a view to launching cooperative study programs and formulating appropriate management measures to effect their sustainable production, with special reference to Article 63 of the Law of the Sea of the United Nations
3. Establishment on a permanent basis of a centralized and efficient regional database for fisheries information and reliable fishery statistics for use in the planning and implementation of programs and projects for the sustainable development and rational utilization of fishery resources of the member countries
4. Strengthening of the human resource capacity of the Member Countries to enable them to achieve the long-term goal of good governance and sustainable fisheries development.

Ingredients Necessary to Support the Efficient Operation of SEAFDEC

It is clear that SEAFDEC in the Twenty-first Century will have a much broader scope of work than in the mid-seventies. Its work will cover not only technical but also economic, social and legal aspects. The efficient running of the Center will, therefore, depend on a number of ingredients. The following suggestions are therefore raised without necessarily interfering with the good judgment of the SEAFDEC Council of Directors.

1. **Sense of ownership of the Center.** Member Countries should recognize that each is an owner of the Center and has every right and privilege to obtain benefits from being a member. Therefore, to ensure the efficiency of the Center, adequate investment or support both in cash and in kind, should be provided, as the Center will have expanding programs of activity envisaged both in the medium and long-term.
2. **Core staff for implementation of the approved programs.** The staff including its manager should be honest and able. In particular, the leader himself should

A "Toast to the Future of SEAFDEC" offered by the Guest of Honor during the Celebration of the 50th Anniversary of SEAFDEC, *H.E. Air Chief Marshal Dr. Prajin Juntong*, the Deputy Prime Minister of the Kingdom of Thailand

have the ability to ensure the smooth running of the organization with good results. A number of research and educational institutions, programs and projects run by private or government entities as well as regional and international organizations are usually efficiently run by able and experienced leaders as well as devoted and competent staff. Some organizations have more funds than others because the managers are amicable and talk convincingly, *i.e.* they are not only diplomatic but very persistent and persuasive. Large organizations can run smoothly because the managers have the ability to create and foster mutual respect among the workers. Successful managers also have a sense of anticipation, based on their accumulated experiences to effect cost savings of the organizations. Therefore, it would be advantageous for the Center to periodically appraise its manpower requirements, like every five or 10 years because it may need more staff to cover not only technical but administrative and legal issues for its expanding programs of activity. Some staff may have to be retrained to perform different tasks as required.

Conclusion

With the strong support from the Member Countries and concerted action between the SEAFDEC Secretariat and the Technical Departments, there is no question why SEAFDEC will not move into the Twenty-first Century and beyond with much confidence and pride.

About the Author

Dr. Deb Menasveta was the Third Secretary-General of SEAFDEC serving from January 1976 to January 1981, and served as the Chair of the Third Review Committee of SEAFDEC in 2012-2013. During the delivery of his Keynote Address, *Dr. Deb* was thankful for the opportunity to be able to participate in and celebrate the fiftieth anniversary of SEAFDEC hosted by the Ministry of Agriculture and Cooperatives of Thailand. He also thanked the Director-General of the Fisheries Department of Thailand *Dr. Adisorn Promthep* and the Secretary-General of SEAFDEC *Dr. Kom Silapajarn* for kindly inviting him and giving him the honor to deliver the Keynote Address during the Celebration of the Fiftieth Anniversary of SEAFDEC. This is considering that he had the privilege to witness the birth of the Center in 1967 until it became a full-fledged and internationally recognized institution responsible for sustainable Southeast Asian fisheries development.

Building upon Sub-regional Arrangements for Joint Management of Fishery Resources in the Southeast Asian Region

Magnus Torell

The Southeast Asian region embraces among others, a vast range of seas including semi-enclosed seas, large rivers and lakes, numerous man-made lakes and reservoirs, and wide areas of wetlands and flooded forests. For the sustainability of the fisheries in these waters, many fora had recommended that sub-regional approach should be promoted to develop joint and/or coordinated management of the resources. Under the ASEAN mechanism, six sub-regional management areas had been identified in the Southeast Asian region. These are: Gulf of Thailand, Andaman Sea, South China Sea, Sulu Sea or Celebes Sea, Arafura Timor Sea, and Mekong River Basin. Through these sub-regional areas as targets of suitable sub-regional arrangements, regional collaboration in the ASEAN could be enhanced. The SEAFDEC-Sida Project implemented in 2000s and subsequently, the SEAFDEC-Sweden Project (2013-2019) has been promoting the development of sub-regional arrangements for the sustainable management of the fishery resources in the Southeast Asian region, focusing on the Gulf of Thailand, Andaman Sea, Sulu-Sulawesi Sea, and Lower Mekong River Basin. To date, sub-regional arrangements have been initiated among the transboundary countries of these sub-regional areas, resulting in the establishment of collaborative agreements for improved management of fisheries and habitats, as well as improvements in the quality and legal status of fish and fishery products from the Southeast Asian region.

Sub-regional focus in support of processes for common approaches to ASEAN fisheries management

Fisheries and fishery resources utilization is of central importance in all regions of the world that are blessed with productive marine and inland water bodies. Fisheries, with a mix of smaller and larger scale operations, is a common feature in many regions worldwide, most especially in the Southeast Asian region. The available aquatic resources is generating opportunities for employment, livelihood and food security for coastal and rural communities as well as providing raw materials for fisheries-based industries that contribute significant export earnings to the coastal countries. In addition, inland river basins like the Amazon, the Nile and the Mekong provide sources of livelihoods, employment and food security for millions of people dependent on the aquatic products.

The world's growing population with increasing demand for fish and fishery products together with pollution and habitat degradation, and competition over space along coasts and inland river basins has led to the recognition among nations that rules and regulations has to be established – and enforced – to manage fisheries, regulate fishing efforts, and to conserve and protect the habitats and aquatic environments. The migratory nature of fish stocks, seasonal variations in river flows, and the effects of seasonal changes in climate patterns go beyond national boundaries. Throughout the world there are calls for bilateral and multilateral agreements on fisheries and habitat conservation with strengthened coordination to jointly work towards sustainable utilization of the fishery and aquatic resources.

In the European Union (EU) for example, support of common efforts to ensure sustainable fisheries and protection of important habitats, common fisheries policies had been developed and agreed upon within the EU. The Common Fisheries Policy is revised and renewed from time to time with gradually stronger and more restrictive provisions. The first Common Fisheries Policy was introduced in the 1970s with the latest one that entered into force on 1 January 2014 (*https://ec.europa.eu/fisheries/cfp_en*). An important feature of the European Fisheries Policy is the sub-regional focus for negotiation on detailed management measures such as regulations of fishing effort with catch allocations to be shared among the bordering countries in dialogue between the EU and non-EU states. Important sub-regions in the EU include the Baltic Sea (EU States and Russia), the North Sea (EU States, Norway, Iceland and Faeroe Island), and the Mediterranean Sea.

Similar to Europe, fisheries and habitats are under increasing pressure in the Southeast Asian region with very strong national and regional dependence on fish and fishery products both for domestic food security and in support of highly profitable export industries. Millions of people are directly involved in and are dependent on fisheries and fisheries-related activities. Countries like Thailand, Indonesia, Viet Nam and the Philippines are among the world's leading exporting countries in terms of fish and fishery products. Bilateral and multilateral cooperation has been growing and improvement of management measures has been promoted through the efforts and support of the Southeast Asia Fisheries Development Center (SEAFDEC) and through the ASEAN Sector Working Group on Fisheries (ASWGFi).

In November 2007, SEAFDEC, with support from then SEAFDEC-Sida Project as the forerunner of the ***SEAFDEC-Sweden Project, organized the ASEAN-SEAFDEC Regional Technical Consultation on the Concept of an ASEAN Fisheries Development and Management Mechanism (AFMM)***. The event and subsequent discussions among the ASEAN Member States (AMSs) led to the establishment of the ASEAN Fisheries Consultative Forum (AFCF), now meeting annually back-to-back with the meetings of the ASWGFi. Based on the interest shown during the Senior Officials Meeting of the ASEAN Ministers of Agriculture and Forestry (SOM AMAF) in 2016 to develop a common fisheries policy, the Department of Fisheries in Thailand responded positively by hosting the "***Technical Consultation on Development of the ASEAN Common Fisheries Policy***" on 27-28 March 2017 in Bangkok, Thailand. The participants included representatives from the fisheries agencies of the AMSs, private sector representatives from the AMSs together with the ASEAN Secretariat, SEAFDEC, FAO and other international and regional organizations. During the said Technical Consultation, there was a general understanding that further steps should build upon the existing policy frameworks, *e.g.* the ***2011 ASEAN-SEAFDEC Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region towards 2020***, and directions for the continued process should be provided through the available ASEAN mechanisms. Another important initiative that has been developed for the region in response to global and increasingly regional, demands to ensure the legal status of fish and fishery products is the "***Regional Plan of Action (RPOA-IUU) to Promote Responsible Fishing Practices including Combating Illegal, Unreported and Unregulated Fishing in the Region***". The RPOA-IUU is endorsed by eight of the AMSs plus Australia, Timor-Leste and Papua-New Guinea. FAO, SEAFDEC, InfoFish, and the WorldFish Center are providing technical advice to the RPOA-IUU. Common to these regional initiatives, which are under a general umbrella of region-wide perspectives, is that specific sub-regional focus should be given to the development of joint or coordinated management plans for fisheries and habitat management, management and control of fishing efforts, and strengthening of the cooperation on monitoring, control and surveillance (MCS) to be able to verify and certify the legal status of the fisheries, thereby reducing levels of illegal, unregulated and unreported (IUU) fishing.

For several decades, the SEAFDEC-Sweden Project had given specific attention to the most important sub-regions of the Southeast Asia, *i.e.* the Andaman Sea, Sulu-Sulawesi Sea, Gulf of Thailand, and the Mekong River Basin due to the uniqueness of these sub-regions in terms of resource abundance, biodiversity, social and cultural importance, ecological significance of global importance, and as major source of economic revenues. In order to have a solid platform for the development of an ASEAN Common Fisheries Policy, it is vital to build upon the existing sub-regional initiatives to promote the perspective of improved management of fisheries, habitats and improvements in quality and legal status of trade in fish and fishery products for the region as a whole.

The important transboundary marine and inland sub-regions in Southeast Asia

In the Southeast Asian region, six transboundary marine and inland sub-regional areas are of vital importance to the socio-economic make-up of the region because of their unique social, ecological and economic characteristics.

Gulf of Thailand Sub-region

The Gulf of Thailand is by the 1982 UN Convention on the Law of the Sea (UNCLOS) definition, considered as a semi-enclosed sea. The Convention encourages countries around the Gulf of Thailand to cooperate to ensure that the available resources are sustainably utilized and the environment is protected. Malaysia, Thailand, Cambodia, Viet Nam and the South China Sea are bordering the Gulf of Thailand (**Fig. 1**), which is made up of a fairly shallow basin of not more than 85 meters in depth. In the upper part of the Gulf, a range of rivers such as Chao Phraya, Bang Pakong and Mae Klong brings nutrients into the Gulf that contribute to high productivity leading to abundance and diversity in fish and other aquatic resources. The increasing populations and growing demand for fishery products in the region and at international markets, had led to the rapid increase in fisheries operations in the Gulf of Thailand with the growth of sizeable larger scale fishing fleets found in Thailand, Malaysia and Viet Nam.

The combined fishing effort of the traditional coastal small-scale fisheries and the large-scale fisheries has led to increased fishing pressure and serious over-fishing in the Gulf of Thailand with significant decreases in catch per unit effort. Parallel to the over-fishing and depletion of resources, the

Fig. 1. The Gulf of Thailand Sub-region bounded by Thailand, Cambodia, Viet Nam, Malaysia, and the South China Sea

Gulf has also been subjected to degradation of its marine and coastal environment with many habitats being threatened, such as mangroves, sea grass beds and coral reefs. Following urban and industrial developments, the levels of pollution has increased substantially, and together with large expansions of tourist developments, coastal resorts and several concessions for gas and oil exploration, have led to competition over space and resources in the Gulf and along its coast. The livelihood and well-being of coastal communities are being challenged due to the depletion of resources and the rapidly decreasing space available for the fishing communities. The situation has led to conflicts between groups of fishers and between fisherfolk, the fishing industry and other sectors demanding for space and exploiting the resources in the Gulf of Thailand.

To mitigate the problems and in effort to work together on the management of fisheries, habitats and fishing capacity, the Gulf of Thailand countries with support from SEAFDEC through the SEAFDEC-Sweden Project, had since 2008 regularly met to discuss common issues and approaches to address the problems and to reverse the negative trends through the development of joint approaches to fisheries management and habitat protection. The SEAFDEC-Sweden Project is not being implemented in isolation but in cooperation with relevant local institutions, *e.g.* Learning Institute of Cambodia (Leng *et al*., 2013). Important contributions to the identification of important habitats with measures to develop *refugia* for the management and conservation of habitats are provided by the SEAFDEC/UNEP/GEF Gulf of Thailand and South China Sea Fisheries *Refugia* Project (Peterson and Yingyuad, 2017).

Fig. 2. The Andaman Sea Sub-region bounded by Myanmar, Thailand, Malaysia, Indonesia, the Andaman and Nicobar islands, the Indian Ocean, and the Bay of Bengal

Andaman Sea Sub-region

The Andaman Sea is an ecologically unique semi-enclosed sea bordered by Myanmar, Thailand, Malaysia, Indonesia, the Andaman and Nicobar Islands, the Indian Ocean and the Bay of Bengal (**Fig. 2**). The topography of the Andaman is more varied compared to that of the Gulf of Thailand, having a large continental shelf in the northern part and in Myanmar. In the central to southwestern part approaching towards the Malacca Straits there is a deep basin with depths down to 2000 meters. The seasonal variations from the north-west monsoon and the south-east monsoon together with the unique topographical patterns of the Andaman Sea, create specific patterns of currents with distinct rip-currents occurring where the water masses meet. These seasonal patterns together with nutrients outflow from rivers such as the Ayeyarwady and Salween supports very productive habitats making the Andaman Sea extremely rich in both biodiversity and abundance of aquatic resources. The Andaman Sea has also seen a rapid increase in fishing activities by small and especially through the growth in fishing by larger scale vessels leading to over-exploitation of commercially important species (SEAFDEC, 2017) such as mackerels, anchovies, neritic tunas, and hilsa. Seasonal closure in specifically sensitive areas and during spawning seasons could help to allow stocks to recover.

The ecological significance, biodiversity, resources abundance and scenic beauty has led to much attention being drawn towards the Andaman Sea not only from the fishing sector but also from coastal tourism that has been supporting a multi-billion dollar industry – and creating problems for coastal communities in terms of competing demands for space in coastal areas. Earlier negative impacts on the marine and coastal environments was caused by the extensive dredging of alluvial tin, but changes in world market prices and increased popularity of coastal tourism has led to shift in investments from tin dredging to tourism. The ecological uniqueness of the Andaman Sea has led to the establishment of the ***Andaman Sea Eco-region*** through nomination by environmental groups like the WWF (*assets.panda.org/downloads/wwfandaman2.pdf*) based on the identification of Andaman Sea as one of the most important eco-regions of the world with calls for specific and strong measures to be imposed to ensure the protection of its ecological values. Information provided (*https://www.worldwildlife.org/ecoregions/im0101*) on the ecological features of the Andaman Sea indicate that there are distinct variation between the northern Andaman compared to its southern part with the dividing “line” being somewhere close to the latitude of Phuket.

Other similar patterns, with one northern "loop" and one southern "loop" has been reported with regards to traditionally important pelagic species such as the Indo-Pacific mackerel and short mackerel (SEAFDEC, 2012). Even if the details need to be confirmed through continued research and assessment, it is obvious that coordinated fisheries and habitat management efforts are required and should be developed between the two countries of the northern Andaman (Myanmar and Thailand), the three countries of the southern Andaman (Indonesia, Malaysia and Thailand) and the four (five if including India) countries of the Andaman Sea. The coordination should be developed with reference to the ecological features, seasonal monsoon patterns, habitat connectivity and fisheries migration, and trans-boundary movements of vessels and landings across boundaries.

The ecological, cultural, economic and social importance of the aquatic and fishery resources of the Andaman Sea to the countries and the sub-region as a whole has also been highlighted with support being provided to strengthening of sub-regional cooperation on fisheries and habitat management through the FAO/BOBLME Project, IUCN/Mangroves for the Future (MFF) and the SEAFDEC-Sweden Project. In addition numerous initiatives are ongoing at national level in the four or five Andaman countries together with sizable private sector investments in fisheries, tourism, offshore oil-explorations, harbors, and industrial estates, among others

(Northern) South China Sea/Gulf of Tonkin

The political boundaries of the South China Sea are highly disputed with basically all littoral states have claims to parts of the South China Sea including the disputed Parcels and Spratly Islands (**Fig. 3**). Following the uncertainties and political tensions the South China Sea is not, for the time being, the target for regular sub-regional dialogues on fisheries, fisheries management and habitat conservation by the SEAFDEC-Sweden Project, RPOA-IUU or other fisheries initiatives with sub-regional focus. The SEAFDEC/UNEP/GEF South China Sea and Gulf of Thailand *Refugia* Project have a focus on the South China Sea but habitat demonstration sites are located close to shore well within "undisputed" territorial seas. Nonetheless, in the Gulf of Tonkin cooperation is ongoing between China and Viet Nam. The South China Sea and Gulf of Tonkin are bordering Viet Nam, People's Republic of China, the Philippines, Malaysia, Brunei Darussalam, Indonesia and the Gulf of Thailand in the Southwestern part.

The coastal fishery resources and type of fishery in the northern South China Sea and Gulf of Tonkin Sub-region, with a mix of smaller and larger scale fisheries, have similar features as that of the Gulf of Thailand and the Andaman Sea with heavy pressure on the resources in the northern part and along the coasts. Seasonal variations follow the changes in the monsoon seasons supported by the outflow of nutrients from the Mekong River, Red River and other major rivers

Fig. 3. The Northern South China Sea and Gulf of Tonkin Sub-region bounded by Viet Nam, People's Republic of China, Philippines, Malaysia, Brunei Darussalam, Indonesia, and Gulf of Thailand

with estuaries and deltas in and around the South China Sea, providing ideal patterns for the spawning, breeding and feeding for important fisheries stocks – and the basis for significant artisanal and commercial fisheries. Discussions on fisheries in the northern part (Gulf of Tonkin) had been going on between China and Viet Nam with the establishment of a fisheries agreement between the two countries on fisheries in the Gulf of Tonkin, which entered into force on 30 June 2004.

Sulu-Sulawesi Seas

The Sulu-Sulawesi Seas are known to be very rich in biodiversity with great abundance of coastal and offshore resources with some 3,000 aquatic species. Important habitats include tuna breeding and spawning grounds, and marine turtle nesting areas. There are limited areas with shallow water and the bottom topography shows fairly deep water areas with 80% of the area between 200 and 5,000 meters deep. The Sulu-Sulawesi Seas are enclosed by Malaysia, the Philippines and Indonesia (**Fig. 4**). The uniqueness and global significance has promoted WWF and others to establish the Sulu-Sulawesi Eco-region.

Support to the eco-region has, apart from the World Wide Fund for Nature (WWF), been provided by the Asian Development Bank (ADB), US Agency for International Development (USAID), and the German Development Agency (GIZ) among others. The cooperation around the Sulu-Sulawesi has been further expanded through the establishment of the "***Coral Triangle Initiative for Corals, Fisheries and Food***

Fig. 4. The Sulu-Sulawesi Seas bordered by Malaysia, the Philippines, and Indonesia

Security" (CTI-CFF). The CTI-CFF is established as an intergovernmental body with six members, namely: Indonesia, Malaysia, the Philippines, Timor-Leste, Papua-New Guinea, and the Solomon Islands. The availability of bountiful fishery resources in the Coral Triangle (**Fig. 5**) has attracted people to engage in fisheries with the aquatic resources being threatened by increased fishing pressure due to population growth leading to heavy over-exploitation including the use of destructive fishing methods. Furthermore, the resources, habitats and unique ecosystem of the Sulu-Sulawesi Seas are threatened by impacts of coastal development, urbanization and other (human) activities. Fluctuations in sea temperature and acidification together with more frequent and intense storms and hurricanes caused by climate variability and climate change adds to problems caused by fisheries and other human activities.

The Sulu-Sulawesi Seas is another target sub-region for the RPOA-IUU with the inclusion of the fishing areas in the southern and south western South China Sea. Regular meetings are organized with the involvement of Brunei Darussalam with results being reported to the annual RPOA-IUU Coordinating Committee. The SEAFDEC-USAID Oceans Partnership Project with a focus on aspects related to the implementation of traceability systems and biodiversity have identified the Sulu-Sulawesi Sub-region as the main

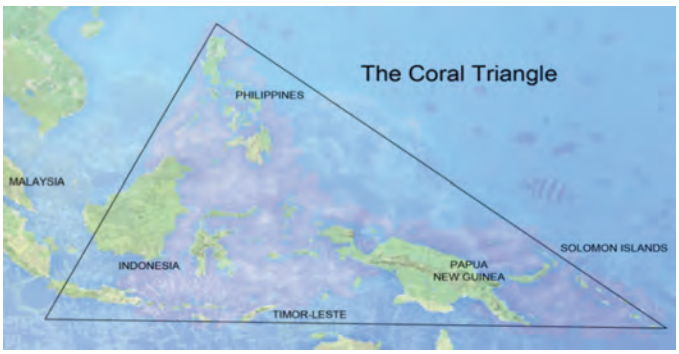


Fig. 5. The Coral Triangle bordered by Indonesia, Malaysia, the Philippines, Solomon Islands, Papua New Guinea, and Timor Leste

area for their activities. The Sulu-Sulawesi is also a target sub-region for the SEAFDEC-Sweden Project but with the actions implemented by the CTI-CFF and the SEAFDEC-USAID Oceans Partnership Project, the SEAFDEC-Sweden Project is only monitoring the progress in the area with options to share results from the Sulu-Sulawesi Seas with other areas.

Arafura-Timor Seas

The Arafura-Timor Seas are rich in aquatic resources and bio-diversity with productive coastal resources together with a larger and smaller pelagic fish species. The Arafura-Timor Seas are bordered by Indonesia, Timor-Leste, Papua New Guinea and Australia, and by the 1982 Law of the Sea definition, the sub-region is also a "semi-enclosed" sea (**Fig. 6**). The fisheries of the area have two distinct features, namely: (1) coastal traditional fisheries; and (2) larger commercial vessels including foreign vessels with licenses to fish in the area, primarily fishing for larger tunas. The picture of the sub-region's fishing pressure is mixed with some species and resources under heavy pressure while in other cases and areas, some resources are not fully exploited. The mixed picture includes areas with conflicts among groups of fishers and encroachment of larger vessels into coastal areas creating problems for coastal traditional fisherfolk.

Fig. 6. The Arafura-Timor Seas bordered by Indonesia, Timor Leste, Papua New Guinea, and Australia

Challenges with regards to management of fisheries include illegal fishing, trans-boundary encroachment together with uncertainties as to the actual fishing pressure due to many fisheries, especially the small-scale traditional fisheries being unregulated with unrecorded catches. Efforts are needed, and gradually being implemented, to support the coastal artisanal fisherfolk by securing their traditional rights and strengthened tenure rights to coastal lands with access to resources and fishing areas. Given that tunas and other larger pelagic species are well managed and controlled, the sub-regional area has a large export potential. To move in this direction and to combat illegal fishing, the bordering countries need to work together

and share information, and to cooperate on monitoring, control and enforcement. The Arafura-Timor Seas is one of target sub-regions for the RPOA-IUU. The cooperation in the area is often cited as a good example of effective cooperation on control of fishing effort in a given sub-region. To strengthen the cooperation on monitoring and control, the arrangements and development of MCS-networks are based on a sequence of bilateral agreements, such as between (a) Timor-Leste and Australia; (b) Indonesia and Australia; and (c) Papua-New Guinea and Australia.

Mekong River Basin

The Mekong River Basin (**Fig. 7**) is very rich in aquatic resources and biodiversity, and second in the world only to the Amazon River Basin (**Fig. 8**). Estimates by the Fisheries Program of the Mekong River Commission (MRC) indicates an annual fisheries production of 2.5 – 3 million tons, with around 60 million people in six countries dependent on the Mekong and its resources. The productivity of the Mekong River depends on the seasonal monsoon patterns with high fluctuation in rain fall, water levels and water turbidity. The wet season reverse flow of the Tonle Sap River and the growth of extended flood plains are triggering fish migration and spawning that, together with maintained connectivity between important habitats are central to the productivity of the Mekong.

Fig. 7. The Mekong River Basin bordered by People's Republic of China, Myanmar, Lao PDR, Thailand, Cambodia, and Viet Nam

Fig. 8. The Amazon River Basin in South America covers an area of about 7,500,000 km^2 or roughly 40% of the South American continent, and bordered by Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname, and Venezuela.

Riparian states of the Mekong River Basin include Viet Nam, Cambodia, Thailand, Lao PDR, Myanmar, and People's Republic of China. The productivity of the river and potentials for navigation, hydropower and irrigation schemes had been the focus for cooperation among riparian states dating back well into the French colonial Indo-China era. In the mid-sixties the predecessor of today's Mekong River Commission (MRC) started to emerge with ambitions to look into options for "developing" the Mekong River Basin and harnessing its resource potential for hydropower and irrigation, among others. In 1995, the four countries of the Lower Mekong Basin, namely: Viet Nam, Cambodia, Thailand, and Lao PDR signed the "***Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin***" and the MRC was established. In response to the importance and uniqueness of the Mekong River Basin, the MRC and efforts to strengthen cooperation among riparian states, received support from major donors since its inception.

Seen from a fisheries perspective, the support being provided by the Governments of Denmark and Sweden since the 1980s to the Interim Mekong Committee and later (after 1995) to the MRC Fisheries and Environment Programme has been important in increasing the awareness of stakeholders on the value and productivity of fisheries in the Mekong River Basin. Further information on fisheries as well as on the economic and social importance of the Mekong fisheries has been generated through the WorldFish Center, WWF Greater Mekong, the International Union for Conservation of Nature (IUCN)-(Mekong, Wetland Alliance, the Asian Institute of Technology (AIT), and others.

In spite of all the available information and the awareness raised in the four countries and globally on the importance and value of Mekong fisheries and the uniqueness of Mekong River Basin biodiversity, the sustainability is challenged by infrastructure developments, *e.g.* hydropower and irrigation dams, roads, urban development, housing and industrial estates, that are reducing the flood plains, obstructing migration paths, losing the connectivity, and altering the river flows. As a result, river developments pose the major threats to Mekong fisheries and not the fisheries as such. In order to reverse negative trends, it is important that the continued seasonal flooding and the seasonal reverse flow of the Tonle Sap River are ensured, and the habitat inter-connectivity with open fish migration paths together with conservation of dry season fish refuges are maintained to secure sufficient fish broodstocks.

In 2016, the MRC had revised their program structure and all the former "sector" programs, including the fisheries program, were closed. In the new program structure, the aspects on fisheries are now incorporated in the work-plan of the new Environmental Program but without the staff capacity and funds available to support the old fisheries program. This has led to concerns being expressed considering that the continuous monitoring of status of fisheries resources with reporting on the health of important habitats would now be lost. Challenges ahead include the need to maintain the inter-governmental monitoring of the status of fisheries, habitat conservation and maintained inter-connectivity. In this respect, SEAFDEC as the main fisheries intergovernmental organization of the region, could assume a role to ensure that the regular monitoring of Mekong fisheries and threats facing the fisheries and people can be maintained and reported in cooperation with fisheries agencies of the Mekong countries. This can be done in cooperation with SEAFDEC and MRC based on a Memorandum of Understanding signed in 2017.

Moving Towards the ASEAN Fisheries Policy

Strengthened sub-regional cooperation with development of joint or coordinated fisheries management plans including research and studies on the social, ecological and economic importance of fisheries and aquatic resources utilization needs to be promoted. This would point at, and increase the understanding of, the very strong national and regional dependence on fish and fishery products both for domestic food security, employment opportunities for millions of people and in support of the very profitable export industries. Improved and coordinated management and environmental protection is also a prerequisite for sustainability. Strong recognition of the local, rural and coastal importance of fisheries and harvesting of aquatic resources is, or should be, an important part of the ASEAN community-building. In this context, similar to the situation in Europe, it is critical to build upon the specific fisheries patterns and traditions of the defined sub-regions. To move in this direction, efforts to promote the further development of an "***ASEAN Common Fisheries Policy***" should be based on the growing bilateral and multilateral cooperation on the efforts to improve fisheries, management measures, habitat protection with coordinated monitoring and control of fishing effort. The steps taken by SEAFDEC with support from the SEAFDEC-Sweden Project, RPOA-IUU, UNEP/GEF Gulf of Thailand *Refugia* Project should be recognized and reported to the ASEAN Sectoral Working Group on Fisheries (ASWGFi) as well as to the ASEAN platforms addressing the ASEAN Socio-Cultural Community Blueprint.

There still seems to be some hurdles to pass on the way to finalize and adopt a "common fisheries policy". Some of the difficulties might be with language used as sometimes objections are raised on the reference to "common fisheries" and to overcome that, the policy directions possibly need to be framed differently. However, further steps towards more coordinated fisheries policies should build upon existing policy frameworks, and that continued policy discussions should refer to the ***2011 ASEAN-SEAFDEC Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region towards 2020*** with directions for the continued process to be provided through the available ASEAN mechanisms. Nevertheless, it should be emphasized that "*to have a solid platform for the further development of an ASEAN Common Fisheries Policy, it is vital to build upon existing sub-regional initiatives to promote the perspective of improved management of fisheries, habitats and improvements in quality and legal status of trade in fishery products for the ASEAN region as a whole*."

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Sustainable Management of Neritic Tunas in Southeast Asia: longtail tuna and kawakawa in focus

Somboon Siriraksophon

Oceanic and neritic tunas are abundant and commonly found in the waters throughout Southeast Asia. While oceanic tunas migrate over oceans and seas, neritic tunas mostly inhabit the economic zones and sub-regional marine waters of Southeast Asia. All tuna resources are economically important in Southeast Asia, generating export revenues for the countries and providing important protein sources for domestic consumption. While the catch of the oceanic tunas is reported to have declined but that of the neritic tuna species continues to increase making these species becoming more important and increasingly the target of exploitation by commercial and local fisheries, especially now that attractive prices are offered by processing companies for such species. Therefore, it is necessary to address the status of and uncertainties in the distribution, migration, and utilization of neritic tuna stocks in the waters and sub-regions of Southeast Asia, prior to the development of appropriate tuna management measures and plans at the national and sub-regional levels.

While management efforts with regards to the exploitation of oceanic tunas in Southeast Asian waters are prescribed by the Tuna Regional Fisheries Management Organizations (Tuna RFMOs), such as the Indian Ocean Tuna Commission (IOTC) and the West Central Pacific Fisheries Commission (WCPFC), important works are also being carried out in the Southeast Asian region for the development of regional approaches to manage the utilization of neritic tunas as well as establishment of collaborative management plans for neritic tuna fisheries to ensure the sustainable use of the available regional resources and maximize the economic benefits from neritic tuna fisheries. Recognizing that regional collaboration is vital for the sustainability of these rich and important transboundary resources, the SEAFDEC Member Countries during the 45th Meeting of the SEAFDEC Council in April 2013, agreed to strengthen regional cooperation for the conservation and management of neritic tuna fisheries in the Southeast Asian waters and called for the development of a plan of action for regional cooperation on neritic tunas in the Southeast Asian region.

At the outset, the SEAFDEC Secretariat and Marine Fishery Resources Development and Management Department (MFRDMD) reviewed the status of neritic tuna capture fisheries in the Southeast Asian region, and with technical support from relevant SEAFDEC Member Countries, came up with the preliminary status and trend of the region's neritic tuna stocks. Based on the recommendations of experts from the SEAFDEC Member Countries pointing towards the need to strengthen regional or sub-regional cooperation for the sustainable utilization of the region's neritic tuna resources based on scientific evidence, SEAFDEC/MFRDMD embarked on a stock assessment project for neritic tunas. Therefore, with the support from a Stock Assessment Expert of the Fisheries and Education Agency (FREA) of Japan and Southeast Asian scientists, a stock assessment of the region's most economically important neritic tuna species, the kawakawa and longtail tuna, was carried out with the objective of generating the corresponding total allowable catch (TAC) for such species. Moreover, to address the possible consequences in the adoption of the TAC in view of the associated uncertainties, risk assessment of these neritic tuna stocks was also carried out.

Neritic Tuna Fisheries of Southeast Asia

In the Southeast Asian region, neritic tunas are caught commercially by three main fishing gears (Siriraksophon, 2013), *e.g.* purse seines and ring nets in the Philippines, and drift-gillnets in Indonesia and other countries. Moreover, three types of purse seine operations are also common in many Southeast Asian countries such as purse seines with the use of searching methods or associated with fish aggregating devices (FADs) or with the use of luring lights. In Thailand, as in other neighboring countries such as Cambodia, Malaysia, Myanmar, Brunei Darussalam, and Indonesia, the purse seine currently being used had evolved from the Chinese purse seine and became widely used after 1957, which had been developed with a unique style of seining appropriate to the conditions of the Southeast Asian countries' waters and was initially developed to catch small pelagic fishes other than tunas. In the case of Thailand, targeting of the small tunas by the Thai purse seine fisheries started only in 1982 after the expansion of Thailand's tuna canning industry. The operation using the Thai purse seine is labor-intensive, involving 30-40 crew members working on vessels ranging in length overall from 25 to 30 m. Lengths of the nets range from 800 to 1250 m, while net depths range from 70 to 120 m, and mesh sizes ranging from 2.5 to 9.7 cm. Nowadays, modern purse seiners in the region are already equipped with radar, depth sounder, sonar transceiver, and satellite navigational instruments.

Drift-gillnets also play an important role in neritic tuna fisheries, especially in the early period of development of small pelagic fisheries in many Southeast Asian countries but

its use had now been overtaken by the purse seines. However, drift-gillnets are still important gear for some Southeast Asian countries such as Indonesia, and in Viet Nam where 37% of the country's total production of neritic tunas at 72,650 metric tons is caught using the drift-gillnets (Thong, 2013).

Issues, Challenges and Regional Plan of Action

The series of regional technical consultations on neritic tunas conducted by SEAFDEC with its Member Countries identified the key issues that impede the promotion of sustainable utilization of neritic tunas in the Southeast Asian region. These include: insufficient data and information; undetermined status of neritic tuna stocks; open access system of the fisheries; inadequate management of neritic tuna resources in some areas; inadequate understanding of tuna management and conservation measures; negative impacts of climate change on neritic tuna stocks; negative impacts of fisheries on the marine ecosystem; illegal, unreported and unregulated (IUU) fishing practices; inadequate infrastructures in fishing ports and landing sites; post-harvest losses and product quality deterioration; inadequate intra-regional and international trade; insufficient benefits to people involved in neritic tuna fisheries and industries; inferior working conditions in fishing vessels; absence of sub-regional action plans for neritic tuna fisheries; insufficient information on status and trends of neritic tunas at sub-regional level; and limited support to intra-regional and international trade. In an effort to address such issues and concerns, the SEAFDEC Member Countries adopted the Regional Plan of Action on Sustainable Utilization of Neritic Tunas in the ASEAN Region (SEAFDEC, 2015) with six (6) objectives and 16 Plans of Action as shown in **Table 1**.

Table 1. Important features in the Regional Plan of Action on Sustainable Utilization of Neritic Tunas in the ASEAN Region

Objectives	Issues and Concerns	Adopted Plan of Action
I) Determining available data and information, improving data collection and developing key indicators	1) Insufficient data and information	1) Improve Data Collection and Analysis for Neritic Tunas
	2) Undetermined status of neritic tuna stocks	2) Assess Neritic Tuna Stocks and Develop Resource Key Indicators
II) Improving sustainable fisheries management	3) Open access system	3) Promote Management of Fishing Capacity
	4) Inadequate management of neritic tuna resources in some areas	4) Promote Sustainable Utilization of Neritic Tuna Resources
	5) Inadequate understanding of tuna management and conservation measures	5) Enhance Understanding of the Management and Conservation Measures of Neritic Tunas
	6) Negative impacts of climate change on neritic tuna stocks	6) Mitigate the Impacts of Climate Change on Neritic Tuna Stocks
III) Improving sustainable interaction between fisheries and marine ecosystem	7) Negative impacts of fisheries on the marine ecosystem	7) Reduce Negative Impacts of Neritic Tuna Fisheries on the Marine Ecosystem
IV) Improving compliance to rules and regulations and access to markets	8) Illegal, unreported and unregulated (IUU) fishing	8) Combat IUU Fishing in the Southeast Asian Region
	9) Inadequate infrastructures in fishing ports and landing sites	9) Improve Infrastructures in Fishing Ports/Landing Sites
	10) Post-harvest losses and product quality deterioration	10) Improve Post-harvest Techniques and Product Quality
	11) inadequate intra-regional and international trade	11) Enhance Intra-regional and International Trade
V) Addressing social Aspects	12) insufficient benefits to people involved in neritic tuna fisheries and industries	12) Improve the Benefits for People Involved in Neritic Tuna Fisheries and Industries
	13) inferior working conditions in fishing vessels	13) Improve working conditions of labor
VI) Enhancing regional cooperation	14) absence of sub-regional action plans for neritic tuna fisheries	14) Enhance and/or Develop Sub-regional Action Plans for Neritic Tuna Fisheries
	15) insufficient information on status and trends of neritic tunas at sub-regional level	15) Assess the Status and Trends of Neritic Tunas at Sub-Regional Level
	16) limited support to intra-regional and international trade	16) Enhance Intra-regional and International Trade

Actions taken by SEAFDEC and the AMSs

Since the adoption of the Regional Plan of Action on Sustainable Utilization of Neritic Tunas in the ASEAN Region (RPOA-Neritic Tunas), SEAFDEC with the support from the ASEAN Member States (AMSs) has been implementing several regional action plans in the respective countries of the Southeast Asian region, as shown in **Box 1**.

Box 1. Regional action plans implemented by the Southeast Asian countries with respect to the RPOA-Neritic Tunas

- Compilation and review of existing data and information on neritic tunas from all related national agencies to understand the status, trend and biological parameters
- Review and strengthening of data collection systems on neritic tunas
- Capacity building for data enumerators, observers, port inspectors, scientists, or other key data informants on species identification and biological information
- Determination of the type of data required for stock assessment or key indicator analysis
- Utilization of the existing Standard Operating Procedures (SOPs) for data collection to determine fisheries key indicators on status and trend of neritic tunas
- Conduct of research on neritic tunas at national level (*e.g.* stock assessment, biological, genetics, tagging programs)
- Capacity building on stock assessment
- Development of the Regional Plan of Action for Managing of Fishing Capacity, and promote sustainable management of fishing capacity
- Enhanced involvement of the AMSs in regional and sub-regional research and study on the impact, adaptation, and mitigation measures of climate change on fisheries particularly on neritic tunas (on-going)
- Conduct of risk assessment on the effective management of neritic tunas based on the stock assessment of individual species
- Conduct of R&D on suitable fishing methods and practices for sustainable utilization of neritic tunas resources and their promotion to the AMSs
- Strengthening of cooperation among the AMSs and with other RPOA-IUU participating countries in combating IUU fishing under the RPOA-IUU Framework (on-going)
- Development and promotion of the ASEAN Guidelines for Preventing the Entry of Fish and Fishery Products from IUU Fishing Activities into the Supply Chain in the ASEAN Region
- Providing technical support to promote proper handling and preservation of neritic tunas onboard and at ports (on-going)
- Development and implementation of traceability system to monitor movement of neritic tuna fish and products in the supply chain for export (*i.e.* origin of catch, transport, processing, storage and distribution)
- Development of arrangements and partnership between fisheries authorities or related agencies and fisheries industries regarding implementation of labor standards in fisheries in accordance with national laws, the International Labor Organization (ILO) Work in Fishing Convention of 2007 (C188/ Work in Fishing Convention, 2007) No. 188 and other related ILO Conventions
- Review of the existing action plans in sub-regions such as Sulu-Sulawesi Seas, Gulf of Thailand, South China Sea, and Andaman Sea
- Establishment of cooperation on R&D to support sub-regional management of neritic tuna fisheries
- Establishment of the SEAFDEC scientific working group on neritic tunas for regional stock assessment and providing scientific advice for policy considerations on neritic tunas management
- Conduct of regular meetings of SEAFDEC scientific working group at a sub-regional and regional levels
- Promotion of the development of ASEAN Catch Documentation Systems
- Enhancement of the promotion of neritic tuna fish and fishery products from small-scale operators

Stock Assessment of Neritic Tunas

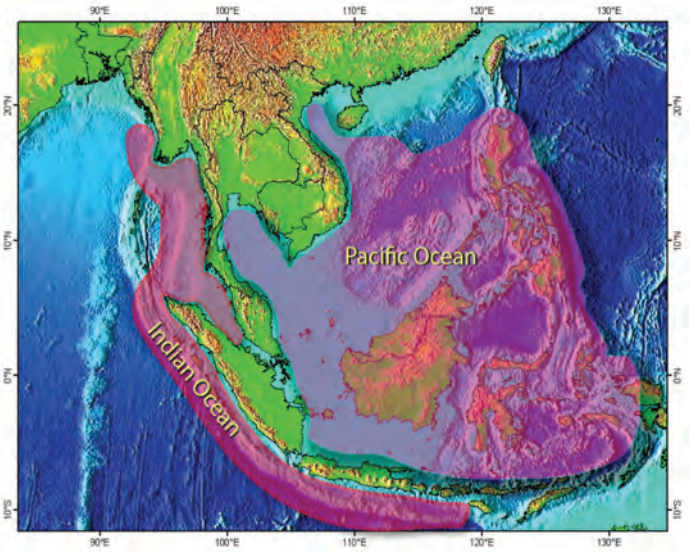

Fig. 1. Two stocks of kawakawa and longtail tuna are reported to be found in: (1) Pacific Ocean side; (2) Indian Ocean side of the Southeast Asian waters (Willette *et al.*, 2016)

In the report of Willette *et al.* (2016), two stocks of neritic tunas are commonly found in the Southeast Asian waters, *i.e.* the Pacific Ocean and Indian Ocean stocks that align with the FAO fishing areas 57 and 71, respectively (**Fig. 1**). Based on such findings, SEAFDEC/MFRDMD initiated in 2016 the stock assessment of commercially-important neritic tunas, such as kawakawa (*Euthynnus affinis*) and longtail tuna (*Thunnus tonggol*) for the Pacific and Indian Ocean sides of Southeast Asia using such techniques as the CPUE standardization, and ASPIC and Kobe plots. The results of the stock assessment activity, conducted in collaboration with concerned AMSs and with the technical support of *Dr. Tsutomu Nishida* from FREA in Japan and other experts of the SEAFDEC Member Countries, are shown below:

Stock assessment of longtail tuna (LOT)

Based on the results of the stock assessment using the Kobe plot (Nishida *et al.*, 2016), it was found that the stock status of longtail tuna in the Indian Ocean side of the Southeast Asian waters as of 2014, is already in the red zone, implying that the stock has been overfished and still overfishing continues. Results of the Kobe plot for LOT indicating that TB/TBmsy=0.89 and F/Fmsy=1.11, means that the current total biomass (TB) is 11% lower than the MSY level, and fishing pressure (F) is 11% higher than the MSY level (**Fig. 2**). Although the catch peaked in 2011, this decreased in 2014 in spite of the slight recovery of the stock in 2014. However, the probability of uncertainties in the unsafe zone (red, orange and yellow areas) of the 2014 point is very high at 78%. Thus, the catch and fishing pressure should be decreased to their MSY levels, *i.e.*, 37,000 metric tons and 0.51%, respectively.

For LOT in the Pacific Ocean side, the stock status as of 2013 was in the green (safe) zone. Results of the Kobe plot indicated that TB/TBmsy=2.22 and F/Fmsy=0.18 implying that TB is 122% higher than the MSY level and F is 82% lower than the MSY level (**Fig. 3**). The catch peaked in 2008 but afterwards it sharply decreased to 193,000 metric tons in 2013, the lowest level since the 1980s, one of the reasons why the stock status is considered to be very safe and the probability of uncertainties in the unsafe zone (red, orange and yellow areas) in 2013 is nil (0%). Therefore, the catch and fishing pressure could be increased but should be less than the MSY levels of TB and F at 200,000 metric tons and 1.07%, respectively.

Stock assessment of kawakawa (KAW)

The 2014 stock status of kawakawa in the Indian Ocean side was in the green zone with F/Fmsy=0.75 and TB/TBmsy=1.28. This means that F is 25% lower than MSY level and TB is 28% higher than its MSY level (**Fig. 4**). Although the stock of KAW in the Pacific side is in the safe condition, the fishing pressure and catch should not exceed the 2014 point because the level of uncertainties around this point is 53% (red, orange and yellow areas in the Kobe plot), while 47% is in the safe (green) zone.

For KAW in the Pacific Ocean side, the current stock status is in the safe zone (green in the Kobe plot) with TB/TBmsy=1.29 and F/Fmsy=0.74. This implies that TB is 29% higher than the MSY level and F is 26% lower than the MSY level (**Fig. 5**). This could be due to the significant catch decrease after 2002 (peak level) and the current catch level which is low.

The Kobe plot also shows that there is no probability that uncertainties in the 2013 estimates fall in the unsafe zone (red, orange and yellow areas in the Kobe plot). Thus, the current catch and F levels could be maintained but should be kept under the MSY levels of TB and F at 185,000 metric tons and 0.43%, respectively.

In carrying out the stock assessment of these neritic tuna species, the catch data from the Food and Agriculture Organization (FAO) and IOTC, as well as the catch data compiled by the coordinators of the SEAFDEC Neritic Tuna Project, were referred to. While almost all data are basically national statistics and could have wide ranges of uncertainties, the vague stock structures could have also contributed to the uncertainties in the results. In addition, considering that the CPUE data are based on the information provided by the Department of Fisheries of Thailand, as the plausible CPUEs from the other Southeast Asian countries were not available, the status of the stocks as results of the assessment could have been mainly influenced by the CPUE series of Thailand, in which case, it might not have been extensive enough for the results of the stock assessment to be reliable.

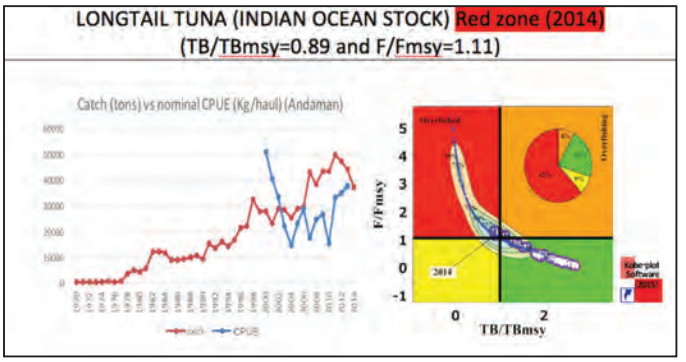

Fig. 2. Results of stock assessment of longtail tuna in the Indian Ocean side of Southeast Asia using Kobe plot

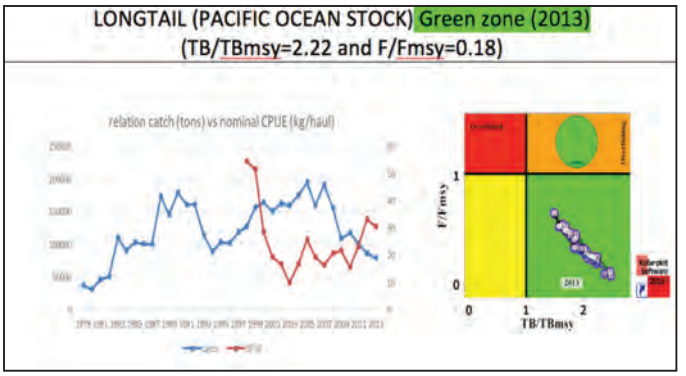

Fig. 3. Results of stock assessment of longtail tuna in the Pacific Ocean side of Southeast Asia using Kobe plot

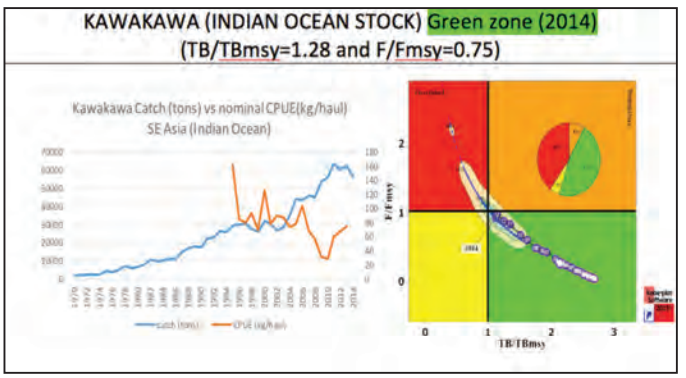

Fig. 4. Results of stock assessment of kawakawa in the Indian Ocean side of Southeast Asia using Kobe plot

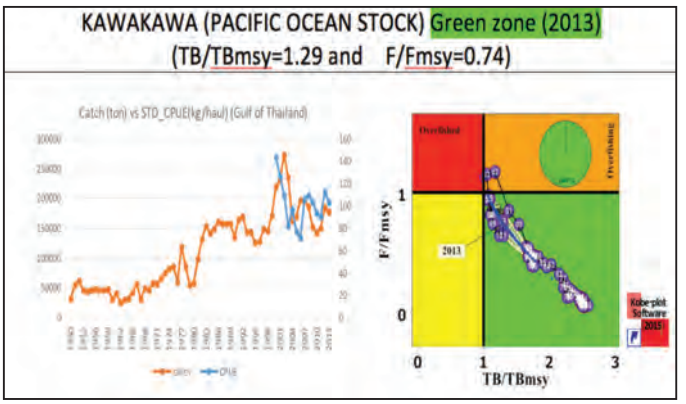

Fig. 5. Results of stock assessment of kawakawa in the Pacific Ocean side of Southeast Asia using Kobe plot

Although there are a number of caveats in this stock assessment effort, there are also some positive evidences that the results are likely realistic. For example, the relationship between catch and CPUE from all four cases, are found to be negatively correlated, indicating that both trends are likely sensible. Hence, the results of the stock assessment are likely believable. Moreover, the results of the assessment of the neritic tuna stocks in the Indian Ocean side of the Southeast Asian waters are similar to those established for the whole of the Indian Ocean by the IOTC (IOTC, 2015; IOTC-WPNT06-2015-21).

Risk Assessment of the Neritic Tuna Stocks

Risk assessment of kawakawa (*Euthynnus affinis*) and longtail tuna (*Thunnus tonggol*) resources in the Southeast Asian waters was also carried out by SEAFDEC/MFRDMD applying the same basic methods as those used by the Tuna RFMOs (Nishida, 2016), *i.e.* the Kobe II Strategy Management Matrix (Kobe II). This is considering that the Kobe II Matrix presents the probabilities that violate and do not sustain the TBmsy (Total Biomass at the MSY level) and Fmsy (fishing pressure at the MSY level) in 3 years and 10 years later using 10 different catch scenarios, *i.e.* current catch levels, MSY levels, ± 10%, ± 20%, ± 30%, and ± 40%. This means that if 10 different catch levels or scenarios were to continue up to the next 10 years, Kobe II would provide the probabilities violating or not sustaining the TBmsy and Fmsy in the 3rd and 10th year.

The Tuna RFMOs use as total allowable catch (TAC), the catch levels which can sustain the TBmsy and Fmsy in 10 years with 50% as the threshold value, which is close to the MSY catch levels. However, different threshold values could also be used, as with the SEAFDEC Neritic Tuna Project, which chose to adopt a more conservative measure and considered 40% as appropriate for its purpose. For a more optimistic measure which could be more advantageous to fishers but is a less conservative approach, a threshold value of 60% could also be an option. The graphical presentations of the results of the Kobe II Matrix using the Kobe plot software (Nishida *et al.*, 2015) are presented in order that non-technical persons such as managers, the industries and the public in general, can easily understand the real situation of the neritic tuna stocks of the Southeast Asian region.

Risk assessment of kawakawa (KAW) stocks

Results of the risk assessment of kawakawa stocks in the Indian Ocean using the Kobe II Matrix, which are presented in **Table 2**, suggest that if the 2014 catch at 59,756 metric tons is continued, the risk of violating the TBmsy and Fmsy is more than 67% in 10 years. For the MSY level at 55,380 metric tons, the risk of violating the TBmsy and Fmsy is less than 45%. Thus, the total catch of kawakawa in the Indian Ocean side of the Southeast Asian waters should be less than its MSY level of 55,380 metric tons. This means that the current catch level at 59,800 metric tons (ave. for 2012-2014 catch) should be decreased by 7%.

The results of the risk assessment of kawakawa stocks in the Pacific Ocean side using Kobe II Matrix shown in **Table 3**, suggest that if the MSY level of the catch at 185,400 metric tons were to continue, the probability of violating the TBmsy and Fmsy is less than 56%. Thus, the total catch of kawakawa in the Pacific Ocean side of the Southeast Asian waters should be less than the MSY level of 185,400 metric tons. This means that the current catch level at 171,000 metric tons (ave. for 2011-2013) can be increased by 9%.

Table 2. Probabilities (%) of violating TBmsy and Fmsy in 3 years (2017) and 10 years (2024): kawakawa, Indian Ocean side of the Southeast Asian waters

Color legend				
Risk levels	Low risk	Medium low risk	Medium high risk	High risk
Probably	0-20%	20-50%	50-80%	80-100

Catch level	60%	70%	80%	90%	93%	100%	110%	120%	130%	140%
					MSY level	Current catch (*)				
10 catch scenarios (tons)	35,854	41,829	47,805	53,780	55,380	59,756	65,732	71,707	77,683	83,658
$B_{2017} < B_{MSY}$	20	24	30	39	41	46	57	64	73	80
$F_{2017} > F_{MSY}$	9	14	20	36	42	59	80	95	100	100
$B_{2024} < B_{MSY}$	7	10	17	36	44	67	87	99	100	100
$F_{2024} > F_{MSY}$	7	9	16	35	45	71	95	100	100	100

(*) The current catch level is the average catch in 3 recent years (2012-2014).

Table 3. Probabilities (%) of violating the TBmsy and Fmsy in 3 years (2016) and 10 years (2023): kawakawa, Pacific Ocean side of the Southeast Asian waters

Color legend				
Risk levels	Low risk	Medium low risk	Medium high risk	High risk
Probably	0-20%	20-50%	50-80%	80-100

Catch level	60%	70%	80%	90%	100%	109%	110%	120%	130%	140%
10 catch scenarios (tons)					Current catch (*)	MSY level				
Projected catch (tons)	102,571	119,666	136,762	153,857	170,952	185,400	188,047	205,142	222,238	239,333
$B_{2016} < B_{MSY}$	5	12	17	26	32	39	40	50	58	65
$F_{2016} > F_{MSY}$	0	0	0	0	16	41	46	73	90	96
$B_{2023} < B_{MSY}$	0	0	0	1	18	56	63	88	96	99
$F_{2023} > F_{MSY}$	0	0	0	0	3	56	66	93	99	100

(*) The current catch level is the average catch in 3 recent years (2011-2013)

Risk assessment of longtail tuna (LOT)

Results of the risk assessment of longtail tuna stocks using the Kobe II Matrix shown in **Table 4**, suggest that if the MSY level of the catch at 37,580 metric tons were to continue, the probabilities of violating the TBmsy and Fmsy are less than 53% in 10 years. Thus, the total catch of longtail tuna in the Indian Ocean (Southeast Asian waters) should be less than the

MSY level of 37,580 metric tons. This means that the current catch level at 43,000 metric tons (ave. for 2012-2014) should be decreased by 13%.

Results of risk assessment of longtail tuna stocks in the Pacific Ocean side using the Kobe II Matrix (**Table 5**) show that the catch level producing the 50% probabilities violating the TBmsy and Fmsy 10 years later (2023) could not be established, additional Kobe II Matrix analysis and corresponding diagrams had to be made as shown in **Table 6** to cover 50%, 100%, 150%, and 200% of the current catch level. The new results suggest that even if the current catch were increased to the MSY level of 196,700 metric tons (123%), the risk of violating the TBmsy and Fmsy is about 50%. Thus, the total catch of longtail tuna in the Pacific Ocean (Southeast Asian waters) can be increased to the MSY level of 196,700 metric tons. This means that the current catch level at 88,200 metric tons (ave. for 2011-2013) can be increased to 108,500 metric tons (*i.e.* 196,700-88,200=108,500 metric tons) or 123%.

Table 4. Probabilities (%) of violating the TBmsy and Fmsy in 3 years (2017) and 10 years (2024): longtail tuna in the Indian Ocean side of the Southeast Asian waters

Color legend				
Risk levels	Low risk	Medium low risk	Medium high risk	High risk
Probably	0-20%	20-50%	50-80%	80-100

Catch level	60%	70%	80%	87%	90%	100%	110%	120%	130%	140%
				MSY level		Current catch (*)				
10 catch scenarios (tons)	25,807	30,108	34,409	37,580	38,710	43,011	47,312	51,613	55,914	60,215
$B_{2017} < B_{MSY}$	48	51	55	57	58	61	64	68	71	74
$F_{2017} > F_{MSY}$	35	41	49	56	59	71	79	87	92	96
$B_{2024} < B_{MSY}$	31	36	45	54	57	71	80	87	90	94
$F_{2024} > F_{MSY}$	31	35	42	53	57	75	87	92	96	98

(*) The current catch level is the average catch in 3 recent years (2012-2014)

Table 5. Probabilities (%) of violating the TBmsy and Fmsy in 3 years (2016) and 10 years (2023): longtail tuna, Pacific Ocean side of the Southeast Asian waters

Color legend				
Risk levels	Low risk	Medium low risk	Medium high risk	High risk
Probably	0-20%	20-50%	50-80%	80-100

Catch level	60%	70%	80%	90%	100%	110%	120%	130%	140%	223%
					Current catch(*)					MSY
10 catch scenarios (tons)	52,894	61,710	70,526	79,341	88,157	96,973	105,788	114,604	123,420	196,700
$B_{2016} < B_{MSY}$	0	0	0	0	0	0	0	0	0	0
$F_{2016} > F_{MSY}$	0	0	0	0	0	0	0	0	0	0
$B_{2023} < B_{MSY}$	0	0	0	0	0	0	0	0	0	52
$F_{2023} > F_{MSY}$	0	0	0	0	0	0	0	0	0	53

(*) The current catch level is the average catch in 3 recent years (2011-2013)

Table 6. Probabilities (%) violating the TBmsy and Fmsy in 3 years (2016) and 10 years (2023) if the current catch were increased by 50%, 100%, 150% and 200%: longtail tuna, Pacific Ocean side of the Southeast Asian waters

Reference point and projection timeframe	Alternative catch projections (relative to the average catch level from 2011–13) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)					
	Current catch (*)	MSY				
Catch level Increased by	0%	50%	100%	123%	150%	200%
Projected catch (tons)	88,157	132,236	176,314	196,700	220,392	264,471
$B_{2016} < B_{MSY}$	0	0	0	0	0	0
$F_{2016} > F_{MSY}$	0	0	0	0	0	78
$B_{2023} < B_{MSY}$	0	0	24	52	84	100
$F_{2023} > F_{MSY}$	0	0	19	53	88	100

Way Forward

The promotion and implementation of the RPOA-Neritic Tunas in the Southeast Asian region should be intensified to ensure the sustainability of the region's neritic tuna resources. It is for such reason that the various fora organized by SEAFDEC to discuss the sustainability of such resources, recommended for the implementation of the ASEAN Catch Documentation Scheme for marine capture fisheries in the AMSs, particularly for neritic tuna fisheries.

Moreover, those fora also suggested that joint trade promotions should be established within and outside the region through the ASEAN Tuna Working Group; exchange of information among the AMSs, *e.g.* legal frameworks, policies and management, trade rules and regulations at sub-regional and regional levels on neritic tuna fisheries should be intensified; the security and safety issues for all types of fishing activities should be recognized by implementing skills training programs; and that the assessment of post-harvest losses of neritic tunas should be conducted while the various ways of reducing post-harvest losses should be identified and described.

Furthermore, those fora had also considered it vital for the AMSs to ensure that their surveillance activities and enforcement are strengthened; control of the importation, landing or transshipment at ports of neritic tunas from vessels presumed to have carried out IUU fishing activities in the ASEAN region without prior clarification from vessel owners or concerned flag States is enforced; measures to refrain the conduct of business transaction with owners and vessels presumed to have carried out IUU fishing activities are established; platforms and fora to facilitate cooperation among scientists and managers are created; the development of information, education and communication (IEC) programs on sustainable use of resources is supported; and management measures to control the fishing effort and capacity at national level and sub-regional levels are developed.

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Going on a high note: the SEAFDEC Information Programs

Virgilia T. Sulit, Nualanong Tongdee, Saivason Klinsukhon, and *Sunutta Pudtal*

Since its establishment in 1967, SEAFDEC has always promoted the importance of information as means of enhancing its image as a regional center working towards the sustainable development of fisheries in Southeast Asia. Thus, with the main objectives of enhancing the management of fisheries of Southeast Asia towards sustainability and raising its visibility, SEAFDEC has institutionalized its Information Programs to focus on the production of three main broad types of materials, namely: institutional materials, fisheries information accounts, and technical reports and scientific articles. Institutional materials include reports of SEAFDEC annual meetings, workshops, seminars, periodic and annual reports of SEAFDEC and Departments, newsletters, Special Publication: Fish for the People. Fisheries information accounts comprise the annual Fishery Statistical Bulletin of Southeast Asia, and the quinquennial Southeast Asian State of Fisheries and Aquaculture. Technical reports include proceedings of workshops, symposia, technical conferences, and end-of-project technical reports, among others, while scientific articles are those papers written by Department staff based on results of their activities carried out in SEAFDEC facilities and published in technical journals. The technical information and related materials produced by SEAFDEC are specifically meant to promote sustainable fisheries management in the Southeast Asian region. Furthermore, databases had also been established in respective SEAFDEC Departments on particular subjects based on their areas of specialization.

Striking a chord: the historical circumstances

Since the establishment of SEAFDEC in 1967, its Secretariat has been taking on the responsibility of implementing and coordinating the information programs and activities of the Center. Among the early tasks of the SEAFDEC Secretariat was the publication of reports of SEAFDEC annual meetings and the quarterly production of the SEAFDEC Newsletter, and dissemination of materials developed by the Departments, to target clientele in the Member Countries of SEAFDEC.

Early on, the Marine Fisheries Research Department (MFRD) of SEAFDEC, which was initially mandated to investigate the status of the region's marine fishery resources for fishing ground development, had been compiling the data gathered from cruise surveys conducted since 1970 using its research vessel, the M.V. CHANGI. With the analyzed data and together with previous relevant data, MFRD published the Catch-and-Effort Statistics of the Offshore Waters of South China Sea from 1969 until 1973. This paved the way for the development of a more comprehensive publication on the catch-effort statistics of Southeast Asia.

Concerned with the urgency of compiling up-to-date fishery statistics for the development of the region's fisheries, the SEAFDEC Secretariat was asked by the SEAFDEC Council of Directors in 1973 to come up with the accounts of the region's fisheries statistics. A working group comprising fishery statisticians of the Southeast Asian region was therefore established in 1974 and tasked to develop the contents and format of the region's fishery statistical bulletin. With full support from concerned countries' agencies involved in compiling their national statistics, the SEAFDEC Secretariat in cooperation with the SEAFDEC Training Department (TD) published in 1978, the first issue of the Fishery Statistical Bulletin for the South China Sea Area containing the 1976 fishery information and data. Taking heed of the recommendation of the SEAFDEC Council, the SEAFDEC Secretariat published the Bulletin on an annual basis, with fisheries production data and other relevant information from the countries in the South China Sea area, such as Brunei Darussalam, China (Taiwan), Hong Kong, Indonesia, Malaysia, Philippines, Singapore, Thailand, and Viet Nam. The Catch-and-Effort Statistics of the South China Sea Area was included as a supplement to the Bulletin from 1976 until 1981. Henceforth, the catch-and-effort data had been incorporated as part of the Bulletin.

As the development of SEAFDEC was progressing fast and its functions expanded to cover not only marine fisheries development but also aquaculture and fisheries post-harvest, and in an effort to facilitate the dissemination of information compiled through its various projects, SEAFDEC launched a massive information program starting in 1981. With funding support from the International Development Research Centre (IDRC) of Canada, the SEAFDEC Secretariat embarked on a three-year project aimed at enhancing the relationship between extension workers and small-scale fishers and farmers in the region through exchange and dissemination of relevant information. Known as the Southeast Asian Fisheries Information Services (SAFIS), the project translated the various fisheries extension materials produced by SEAFDEC Departments into the languages of the Southeast Asian countries and disseminated to target clientele in the region. A network of fisheries information services in the Southeast Asian countries was set up through SAFIS, which had served as the basic structure of the subsequent information projects of SEAFDEC.

In an effort to expand SAFIS, SEAFDEC also implemented a six-year information project starting in 1983 to include not only information compilation but also library services to rationalize and enhance the dissemination of information. Also funded by the IDRC of Canada, the Southeast Asian Fisheries Information System (SEAFIS) was meant to establish national fisheries bibliographies as well as regional bibliographies on fisheries and aquaculture. Therefore through SEAFIS, the SEAFDEC Secretariat was able to respond to requests for information on various aspects of Southeast Asian fisheries from various clients within and outside the region. Moreover, SEAFDEC was able to promote self-reliance in fisheries information dissemination through regional cooperation, as SEAFIS served as the Southeast Asian regional input center for the Aquatic Services and Fisheries Information System (ASFIS) of FAO.

At the Department level, information dissemination has been carried out through their respective libraries. The Library of TD which was set up in 1973 continues to expand its collections through acquisitions, donations and exchanges. The main function of the TD Library is to serve the training and research staff of TD and the trainees who study at TD. With the completion of the Library Building in 1995, the new library standardized format and system for effective library services had been introduced and a computerized cataloging system developed to accommodate the growing number of library collections and users.

As TD sustains its support to the SEAFDEC Secretariat for the production of the Fishery Statistical Bulletin for the South China Sea Area starting in 1976, it also initiated its Audio-Visual Program in 1985 initially to produce audio-visual aids for the various training courses offered by TD, as well as provides inputs to the TD training courses for extension officers, especially in communication media design and development. Thus, the Program not only supports the training and research activities of TD but also promotes public awareness through its various audio-visual activities.

SAFIS publications

SEAFIS publications

Meanwhile, the Library of SEAFDEC Aquaculture Department (AQD) had sustained the acquisition of substantial volumes of aquaculture materials, which had been accelerated through the installation of the Aquaculture Information System (AQUIS) in 1981. Through the FAO/UNDP-Network of Aquaculture Centres in Asia (NACA) Project, AQD acquired a computer mainframe and accessories for the computerization of its Library's material storage, retrieval and reproduction systems, and enhanced its information dissemination activities through AQUIS.

In 1984, AQD received a six-year grant from the IDRC of Canada for the establishment of the Brackishwater Aquaculture Information System (BRAIS) which was aimed at providing a regional database of aquaculture information through the establishment of links with other regional and international information systems. BRAIS also subsidized the acquisition of add-on computer facilities including the MINISIS software and Micro CDS/ISIS to facilitate the setting up of an aquaculture database at AQD, as well as for the expansion of AQD Library's computerized storage and retrieval systems. Aside from the publishing and disseminating aquaculture abstracts, state-of-the-art reviews and other aquaculture materials, BRAIS was also instrumental in linking the local fish farm operators, aquaculture industries and support agencies for the first time, to the leading aquaculture research and development centers all over the world.

BRAIS publications

After its establishment in 1992, the Library of the SEAFDEC Marine Fishery Resources Development and Management Department (MFRDMD) continued to increase its collection of fisheries-related publications. In 1996, MFRDMD established the Fishery Resource Information and Management System (FRIMS) to provide the Department with a proper facility for data collection, management and analysis. FRIMS is also capable of providing data access to other SEAFDEC Member Countries. MFRDMD also continued to take up the previous tasks of MFRD in compilation and publication of the Catch-Effort Statistics for the South China Sea Area starting in 1994 which in the interim was taken over by TD, as

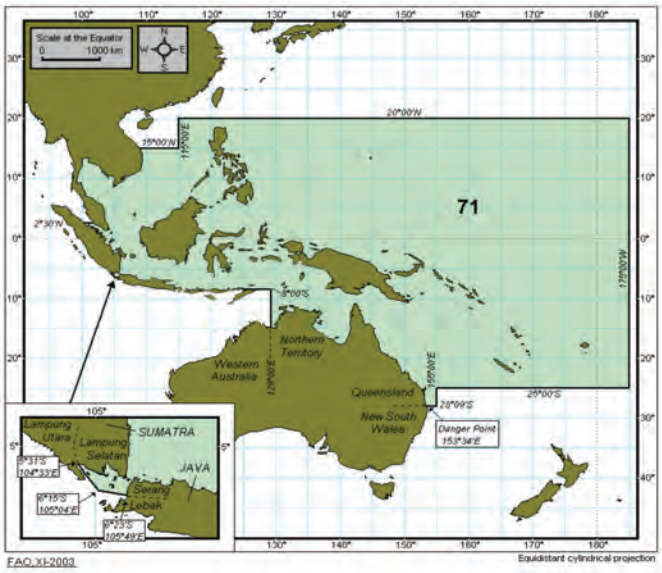


Fig. 1. FAO Fishing Area 71: Western Central Pacific

well as the collection of tuna statistics in the Southeast Asian region indicated as FAO Fishing Area 71 (**Fig. 1**). The data gathered by MFRDMD included tuna and tuna-like species in seven participating countries, namely: Brunei Darussalam, Indonesia, Malaysia, Philippines, Singapore, Thailand, and Viet Nam. Such data were analyzed and published as the Tuna Fishery Statistics Bulletin since 1996, but later on, the said data had been incorporated as part of the Fishery Statistical Bulletin for the South China Sea Area.

As early as 1994, the accessibility, availability and timeliness of information had been identified as one of the major issues affecting the effective and efficient utilization of fishery information in the Southeast Asian region. In a study on "Fisheries Information Needs in Developing Countries: Issues, Constraints and Opportunities" carried out by the Strategy for International Fisheries Research (SIFR) of Canada (SEAFDEC, 1994), the results pointed to the need for various types of information, *e.g.* biological data, extension materials, policy statements and regulations, scientific literatures and technical reports, socio-economic data and indicators, for sustainable management of the fisheries sector. The study also identified the fishery information services and sources available during the survey, many of which still exist to date (**Box 1**).

The abovementioned study also identified the main issues and constraints that affect the effective and efficient utilization of fishery information. These include: accessibility, availability and timeliness of services; compatibility, reliability, and currency of information; appropriateness, completeness, relevance, suitability, and utility; sustainability; and

Box 1. Fishery information systems, services and sources worldwide

Categories	Fishery information systems, services and sources	Remarks
International information system	*International Information System for the Agricultural Sciences and Technology* (AGRIS)	Operational since 1975 at FAO Headquarters, Rome
	Aquatic Sciences and Fisheries Abstracts (ASFA)	Ongoing, based at FAO Headquarters, Rome
	Aquatic Sciences and Fisheries Information System (ASFIS)	Ongoing, based at FAO Headquarters, Rome
Commercial Products	*Biological Sciences Information System* (BIOSIS)	In U.K. and part of Thomson Reuters Web of Knowledge suite
	Commonwealth Agricultural Bureau International (CABI)	Operational since 1910 in U.K. and changed recently to the *Centre for Agriculture and Bioscience International*
	Fish and Fisheries Worldwide (FFW)	Had been recently incorporated with *Aquatic Biology, Aquaculture and Fishery Resources*, and renamed the *Fish, Fisheries and Aquatic Biodiversity Worldwide*
	Current Contents (CC)	Formerly known as the Institute for Scientific Information (ISI)
	Scisearch	Provided by Clarivate Analytics
	Zoological Record	1980-2004 published by *BIOSIS*, 2004 to date by *Thomson Reuters*
International and regional bodies	*FAO and FAO's various Commissions*	Ongoing
	Indian Ocean Commission (IOC)	Ongoing
	Intergovernmental Organization for Marketing Information and Advisory Services for Fishery Products in the Asia and Pacific Region (INFOFISH)	Launched in 1981 in Malaysia as a project of FAO, became an intergovernmental organization since 1987
	Bay of Bengal Programme (BOBP)	Operational in India, now the *Bay of Bengal Programme – International Organisation* (BOBP-IGO)
	Network of Aquaculture Centres in Asia-Pacific (NACA)	Operational since 1988 in Bangkok, Thailand

Box 1. Fishery information systems, services and sources worldwide (Cont'd)		
Categories	**Fishery information systems, services and sources**	**Remarks**
Information programs of international and regional institutions	*Agricultural Information Bank for Asia* (AIBA)	Under the *Southeast Asian Regional Center for Graduate Study and Research in Agriculture* (SEARCA) in Los Baños, Laguna, Philippines
	International Center for Living Aquatic Resources Management (ICLARM)	Established in 1977 in the Philippines, and later renamed as the *WorldFish Center* with headquarters in Penang, Malaysia
	Southeast Asian Fisheries Development Center (SEAFDEC)	Treaty organization established in 1967, now operates the SEAFDEC Secretariat in Bangkok, Thailand and Technical Departments in Thailand, Singapore, Philippines, Malaysia and Indonesia
Professional societies and research networks	*International Association of Marine Science Libraries and Information Centers* (IAMSLIC)	Established in 1975 in Massachusetts, USA
	Asian Fisheries Society (AFS)	Operational since 1984 in Selangor, Malaysia
	Aquaculture Genetics Network of Asia (AGNA)	Regional network funded by the *International Development Research Centre* (IDRC) of Canada
	Network of Tropical Fisheries Scientists (NTFS)	Organized by ICLARM in 1982
Regional information systems		
National information systems		

Source: SEAFDEC (1994)

qualification of information staff. Specifically, the major concerns were: insufficient local and institutional information resources and services due to poor local communication and transportation infrastructure; inadequate systematic methods and mechanisms for collection, organization, analysis, synthesis and dissemination of information; insufficient number of information staff; weak leadership; and inadequate financial support and resources.

The study suggested some actions necessary to improve the utilization of fishery information in Southeast Asia. These include: improving local or national information resources and services; summarizing, packaging and disseminating fishery technology on locally appropriate form; analyzing and synthesizing information in the context of national and local fishery resources management needs and issues; compiling, producing, and disseminating comprehensive directories and inventories on fisheries infrastructure; networking and sharing of information resources and skills; developing national and regional capabilities to facilitate information flow and utilization; and ensuring the sustainability of information systems.

Plight of SEAFDEC Information Programs

As the financial grants from various sources that sustained the information programs of SEAFDEC were concluded after the projects had been completed, the SEAFDEC Secretariat and Departments continued their information-related activities at low scale using their respective financial resources. Notwithstanding such minimal scale, acquisition of information materials was continued mostly through

Some of the regular publications produced by the SEAFDEC Secretariat

exchanges. While recognizing the need to promote the image of SEAFDEC as a unified organization, the SEAFDEC Council asked SEAFDEC in 1994 to develop an information staff exchange program involving the concerned staff of the Departments that would aim for the enhancement of information networking in the Southeast Asian region. This paved the way for the implementation of the SEAFDEC Information Staff Exchange Program (ISEP) which was launched in 1995, and later renamed the SEAFDEC Information Staff Program (ISP).

Recognizing the vital role of information as a tool in the development and management of the fisheries sector, the SEAFDEC Council adopted in 1998 the Center-wide Information Network Program, aimed at keeping the SEAFDEC Member Countries, other organizations and the public well informed of the SEAFDEC activities; raising public awareness and visibility of SEAFDEC; and providing various forms of fisheries information to support decision-making, management and development of the fisheries sector. Guided by the SEAFDEC Information and Communication Policies, several information materials and services had been developed and/or enhanced by the SEAFDEC Secretariat as coordinator of the Program, in collaboration with the SEAFDEC Technical Departments. In line with achieving such objectives, various information materials have been produced to promote the activities and visibility of SEAFDEC, communication among SEAFDEC staff as well as with Member Countries and other organizations has been enhanced, and human resource development opportunities have been provided to relevant SEAFDEC staff to improve not only their skills but also their knowledge on the programs and activities that SEAFDEC has been carrying out.

Having considered the need to streamline information activities in a most cost-effective manner, and to enhance the visibility of the Center, the SEAFDEC Council adopted the Information Strategies for Enhancing SEAFDEC Visibility and Communication in 2007 (**Box 2**), which also includes performance indicators for future implementation as framework for the formulation and implementation of SEAFDEC information activities under the Center-wide Information Network Program. The SEAFDEC Council also encouraged the SEAFDEC Secretariat to monitor and evaluate the implementation of the Strategies by the SEAFDEC Departments, the progress of which should be reported and discussed for improvement during the annual Meetings of the SEAFDEC ISP.

Box 2. Main Features of the Information Strategies for Enhancing SEAFDEC Visibility and Communication

Strategy 1: Production of relevant, timely, and useful information materials to meet the requirements of target audience

Strategy 2: Capacity development of information staff at all levels

Strategy 3: Enhancing the accessibility of SEAFDEC information to target groups

Strategy 4: Strengthen cooperation and networking with other organizations

Strategy 5: Enhance internal communication and information sharing

Strategy 6: Raising SEAFDEC image at international, regional and national levels

Strategy 7: Sustainability of financial support for information and communication activities

Strategy 8: Regular monitoring and evaluation of information activities

Meanwhile in 2003, the Member Countries of SEAFDEC had expanded to include all ASEAN Member States, so that the SEAFDEC Secretariat refocused the compilation of fishery information and statistics for Southeast Asia. Thus, the Fishery Statistical Bulletin for the South China Sea Area which was published by SEAFDEC annually since 1978 was changed to the Fishery Statistical Bulletin of Southeast Asia. This necessitated the compilation of fishery statistics from the Southeast Asian countries and Members of SEAFDEC. So, starting with the information and statistics in 2008, the new Statistical Bulletin published annually now covers the Southeast Asian countries, namely: Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam.

Paradigm shift in information dissemination

The libraries of SEAFDEC Secretariat, TD, MFRD, AQD, MFRDMD, and recently the IFRDMD have continued to provide information services for their respective staff members as well as external visitors. For the Secretariat, the library contains publications produced by the Secretariat and Departments, and aimed primarily to serve as reference materials for staff and visitors. With collections of reference materials produced by SEAFDEC and other sources, particularly on subject matters that fall under their mandates, the Department libraries offer general library services, book loan services (including interlibrary loans), and on-line information services through their departmental websites as well as online bibliographic search. These services are

Launching of SEAFDEC Information Staff Exchange Program in 1995

meant to help in enhancing the dissemination and sharing of SEAFDEC information with the Member Countries, other international and regional organizations, and the public. The libraries have also established cooperation and exchanges of publications produced by SEAFDEC with other libraries and relevant regional and international organizations all over the world. The SEAFDEC libraries have demonstrated the best examples of creating a platform where information and communication technologies are being maximized to reach out to the users.

With the onslaught of changes in information and communication technology services, the SEAFDEC libraries have to adapt the new technologies to meet the challenges in information dissemination. This paved the way to the enhancement of the libraries' on-line services. The AQD library has advanced in this aspect as most of its collections are now being digitized and online information services are provided through a WebOPAC using the OPAC/Follet software, which was launched in July 2000, and recently through other web systems as well. The Online Public Access Catalog (OPAC) is a comprehensive listing of available library collection that the public can access using the internet facilities.

In July 2011, AQD launched an on-line repository of the in-house and external publications of its researchers to provide the public with free and easy access to scholarly and reliable aquaculture research information. The SEAFDEC/AQD Institutional Repository (SAIR) (*http://repository.seafdec.org.ph*) makes use of DSpace, an open-source software developed by the library of the Massachusetts Institute of Technology of USA, and is Open Archives Initiative (OAI)-compliant. Initially, SAIR contains preprints, full-texts or abstracts of journal articles, books and conference proceedings written by AQD researchers and published in international and peer-reviewed publications, and in-house publications such as fish farmer-friendly books, handbooks, policy guidebooks and extension manuals. It also contains institutional and annual reports, conference proceedings and newsletters (*e.g.* Aqua Farm News and SEAFDEC Asian Aquaculture) which can be retrieved and downloaded. Future contents will include images, presentations, as well as audios and videos. SAIR aims to provide reliable means for AQD researchers to store, preserve, and share their research outputs, as well as provide easy access and increase the visibility of AQD scientific publications and technical materials.

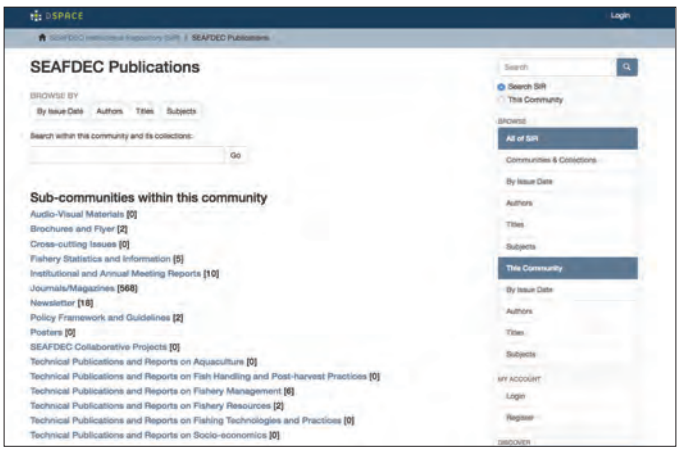
Recognizing the advantages of SEAFDEC Institutional Repository (SIR) in enhancing the visibility of SEAFDEC, the Sixteenth Meeting of the ISP in 2015 encouraged all Departments to develop their respective institutional repositories to be coordinated into the SIR. As a means of formalizing the establishment of the Departmental repositories, the SEAFDEC Secretariat organized the

Box 3. Benefits that could be obtained through the establishment of SEAFDEC Institutional Repository

- Repositories facilitate sharing of SEAFDEC information to external clients and users and increasing its visibility
- The Institutional Repositories of SEAFDEC can be harvested by other search engines and repositories, thus enhancing SEAFDEC visibility
- Repositories allow better searching of SEAFDEC materials through search engines (*e.g.* Google, Worldcat) than through SEAFDEC websites, while materials could be searched not only from bibliographic records, but also the metadata and contents (for PDFs that has been subjected to Optical Character Recognition (OCR))
- Through a centralized repository hosted by SEAFDEC Secretariat, users will able to access all SEAFDEC publications (of all Departments), as the system allows the institutional repository of the SEAFDEC Secretariat to harvest materials available in Departments' institutional repositories automatically (minimizing redundancy of files at both Departments and Secretariat)
- The SEAFDEC Institutional Repository will serve as the digital archive of each Department and all contents would have permanent and persistent link (URL) in the future.

SEAFDEC Inter-Departmental Workshop on Establishment of Institutional Repository of SEAFDEC Secretariat and Departments in March 2017 in Thailand. As the Departmental repositories could accommodate various types and forms of information based on results of SEAFDEC works, these would ensure enhanced access and dissemination of information materials produced by SEAFDEC and improve the visibility of SEAFDEC to the public. Although the SEAFDEC Secretariat and Departments have been maintaining their own information materials accessible through their respective websites and through a compilation available DVD-ROMs, the creation of institutional repositories using the same DSpace platform is being promoted within SEAFDEC in view of the additional anticipated benefits that could be derived from establishing institutional repositories (**Box 3**).

Based on the results of the 2017 Workshop, the Secretariat and Departments have already initiated the establishment of separate repositories, which would carry the domain names: *repository.seafdec.org* (for the SEAFDEC Secretariat and MFRD), *repository.seafdec.or.th* (for TD), *repository.*



Example of community and sub-communities in the SEAFDEC Institutional Repository

seafdec.org.ph (for AQD), *repository.seafdec.org.my* (for MFRDMD), and *repository.seafdec.org.id* (for IFRDMD) which would be maintained by the Secretariat and the respective Departments. To minimize duplication of efforts, the repository of Secretariat would only link to the PDF files stored in Departmental repositories and not harvest the files from the Departments. Thus, the Secretariat would maintain only a smaller server than those of the Departments.

Way Forward

As the platform that would facilitate the monitoring and evaluation of the implementation of the Information Strategies for Enhancing SEAFDEC Visibility and Communication, ISP meetings are convened annually. During the Eighteenth Meeting of the ISP in Singapore in October 2017, the SEAFDEC Secretariat and Departments agreed to exert more efforts in finding the ways and means of improving the information-related activities and enhancing the visibility of SEAFDEC notwithstanding the considerable progress that had been based on the agreed indicators for monitoring the implementation of the SEAFDEC Information Strategies.

Specifically, enhancement of the visibility of SEAFDEC would be made further by SEAFDEC Secretariat and Departments through the use of video channels, *e.g.* YouTube as well as social media, *e.g.* Facebook, especially for uploading not only publications but also the URL of videos produced by the Departments. The SEAFDEC Secretariat and Departments would develop and/or improve their respective institutional repositories as these would enhance public access to publications produced by SEAFDEC, particularly through search engine, and increase the visibility of SEAFDEC to the public. In this connection, monitoring of citations of SEAFDEC publications would be carried out, which would be facilitated through the use of citation databases, *e.g.* Web of Science, Scopus, Google Scholar. Such effort could enhance not only the motivation of Department staff to write more articles but also the credibility of SEAFDEC as source of useful technical materials required by the target audience.

Moreover, the SEAFDEC Secretariat and Departments would soon be creating their respective Google Scholar accounts for their technical staff (using official e-mail address) to facilitate the monitoring of the citations. This would also pave the way for monitoring the usefulness of SEAFDEC publications to users, and enables SEAFDEC to know the kinds of publications and articles that people are interested in and to respond to such needs.

During its past 50 years, SEAFDEC has been exerting efforts to enhance its visibility not only in the Southeast Asian region but also to the whole world, through the production and dissemination of various information materials, and networking with other information systems worldwide. Along this direction, the responsibility of AQD in providing inputs including publications of SEAFDEC Secretariat and Departments to the Aquatic Sciences and Fisheries Abstracts (ASFA) would be sustained as through this platform, the accessibility of SEAFDEC publications is improved and the visibility of SEAFDEC is enhanced.

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Sustainable Management of Inland Capture Fisheries for Food Security: Experience of Indonesia

Agus Djoko Utomo and *Samuel*

An archipelago with 17,500 islands, Indonesia is situated between latitude 06°08' N – 11°15' S and longitude 94°15' – 141°00' E and its territorial waters on 12 mile-limit basis, embrace a total area of 3,166,162 km² and coastline of about 80,791 km. The country's registered land area is about 191,944,300 ha. Economic development program has been implemented in Indonesia since 1969 but little has been done to develop its capture fisheries in inland open waters, *e.g.* lakes, rivers, reservoirs and flood plains. Efforts to achieve sustainable capture fisheries in inland open waters are generally not based on scientific information resulting in less developed technologies on inland capture fisheries, in spite the country's long history of capture fisheries in inland open waters which has been going on for centuries (Sarnita, 1987). Considering that the inland waters are the most important source of income for the rural people, there is a need to manage the country's inland open water capture fisheries for sustainability. Nonetheless, certain alternatives have been promoted in Indonesia to manage the country's inland water fisheries, and this is through stocking and restocking of inland waters with cultured fish species, and establishing of fish reserves in inland waters.

Open Water Fisheries

In many Southeast Asian countries, open waters play a significant role in increasing fishers' incomes, fulfilling the nutritional requirements of rural people by providing food fish, enhancing the local's original incomes, serving as habitats of aquatic organisms, and facilitating environmental balance. In spite of their multifunctions, open waters remain a common property, while activities carried out in open waters could be directly or indirectly influenced by the water quality that to some extent impact on the aquatic flora and fauna including fishes. Inland open water areas abound in many Southeast Asian countries as shown in **Table 1**.

Table 1. Inland open water areas in Southeast Asian countries

Country	Total land area (ha)	Inland open water area (ha)
Indonesia	191,944,300	***16,361,470
Thailand	51,400,000	**4,545,000
Philippines	29,940,400	**361,000
Malaysia	33,123,800	**307,460
Singapore	60,200	*3,000

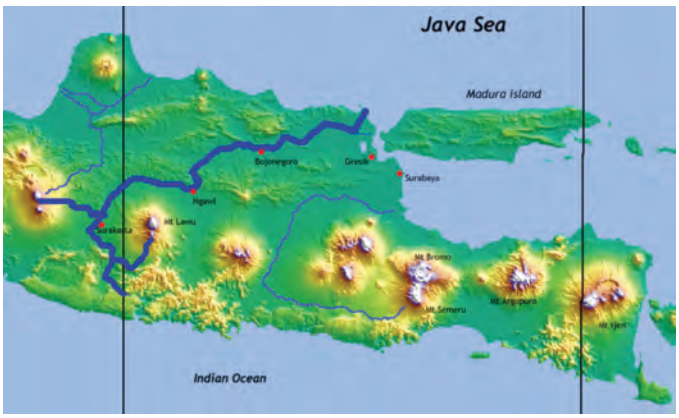
*Source: * Fernando (1980); ** Baluyut = (1983); *** Sarnita (1987)*

As shown in **Table 1**, Indonesia has the largest area of inland open waters compared with the other Southeast Asian countries. However, based on the country's fishery statistical information there is a tendency for Indonesia's fisheries production from open waters to decrease, considering that some fish species are already becoming extinct due to environmental degradation and overfishing activities. Modification of water bodies by constructing dams and reservoirs limit the movement of migratory fish species which could possibly result in their extinction.

Map of Indonesia

Furthermore, land reclamations also lead to loss of specific habitats, for example, conversion of swampy forests into aquaculture areas reduces the spawning grounds of some important fish species, depriving them of reproduction and eventually driving them to virtual eradication. The continued practice of irresponsible fishing activities such as the use of electricity for fishing (*strum*), filtering device (*tuguk*), poison (*racun*) and non-selective gear also leads to destruction of fish stock populations. Some fishing operations that make the target fishes unconscious (*bius*) and the use of large operating gear such as "*ngesar*" (active seine), "*ngesek*" (active barrier), "*empang*" (barrier with traps chamber) could lead to overfishing that results in decreasing fish population, especially, those fish species that spawn only once in one year.

One of the open waters in Indonesia that had undergone modifications and experiencesd ecological pressure is Bengawan Solo River or Solo River, for short, while the Musi River in South Sumatera and Kapuas River in West Kalimantan also underwent few modifications. Musi and Kapuas Rivers have areas devoted to fishery resource conservation such as Lake Belaiaram and Sentarum in West Kalimantan, and Lake Teluk Rasau and Lake Cala in South Sumatera. At least half a million Indonesian fishers are fishing in the country's inland open waters every year.



Bengawan Solo River on the island of Java in Indonesia is approximately 600 km long with basin size of 16,100 km^2

Dam constructed in Solo River

Contribution of Open Water Fisheries to National Economy of Indonesia

Flood plain areas are among the major open waters with high productivity. In South Sumatera for example, these areas supply the local communities' requirements for nutritious food from fish with an average food demand of 23 kg/capita/year. The flood plains in South Sumatera had been managed by the Ogan Komering Ilir (OKI) and Musi Banyuasin (MUBA) Regencies. Records have shown that an average of 16,700 metric tons of fish per year is contributed by OKI and another 11,600 metric tons/year by MUBA to the country's total fisheries production from inland capture fisheries. The number of fishers under OKI is 5000-9000 KK (family). Using traditional gear (hook and lines, cast net, traps), the average catch of fishers is 2-6 kg/day/fisher with average price of Rp.7000-Rp.10,000/kg (as of 1992).

Map of Indonesia showing Sumatra (traditionally known as Sumatera)

However, some fisher groups are using large fishing gear such as *tuguk* (filtering device), *ngesar* (active seine) and *hampang* (barrier traps) with fish catch of 10.0-20.0 metric tons/year for *tuguk*, 2.0-5.0 metric tons/season (August-September) for *ngesar*, and 0.5-1.0 metric tons/season (April-May) for *hampang*. The country's open waters also contribute to the local's original incomes (*pendapatan asli daerah* (PAD)), which is mainly used for development projects. The Regencies of OKI and MUBA contribute to PAD from the proceeds of the retribution and auction of flood plain areas, which are auctioned every year by the local government. Such auction system is one of the ways of authorizing fishers to use the open waters in order to minimize competition and fighting for rights in the fishing areas. In 2003, the contribution of OKI Regency to PAD from the auctions of flood plain areas comprised 40-45% of the total PAD valued at 1.0 billion Rupiah. As of 2011, the average yield of open water capture fisheries in Indonesia was 309,721 metric tons/year. At an average fish price of Rp. 5000/kg (2001 prices), this implies that the averge value of the total catch from open water capture fisheries could amount to Rp.1,548,605,000,000 (as of March 2017, 1.0 US$ = Rp. 13,361).

Status of Inland Capture Fisheries in Indonesia

Fish species

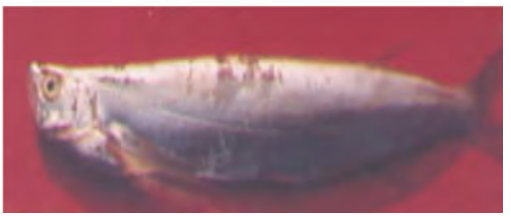
The inland open waters of Indonesia embrace a diversity of fishes, and more than 800 fish species from two orders of fish, namely: Ostariophyci and Labyrinthici dominate the fish populations in Sumatera and Kalimantan with more than 368 species (Sarnita, 1977). In the report of Kottelat *et al*. (1993), the continental flat of Sunda has 798 fish species, the continental flat of Wallacea with 68 fish species, and the continental flat of Sahul has 106 fish species. Kapuas River has more than 200 freshwater fish species (Dudley, 1996), while Barito River has more than 104 fish species and Musi about 120 fish species (Prasetyo *et al*., 2004; Samuel *et al*., 2001; Utomo *et al*., 1993). Many kinds and abundance of fish species are found to be more dominant in middle streams found in many swampy forest areas than in the upper and lower streams.

Box 1: Important freshwater fish species that are now seldom found in Indonesia's flood plains			
Local Name	**Scientific Name**	**Local Name**	**Scientific Name**
Tangkleso	*Shclerophages formosus*	Sengarat	*Belodonticthys dinema*
Kapas-kapas	*Rochteichthys micropeltis*	Temparang	*Macrothiricthys microphirus*
Ikan Elang	*Datniodes quadrifsciatus*	Puntung hanyut	*Balantiocheilos melanopterus*
Timah-timah	*Cryptopterus apagon*	Lumajang	*Cyclocheilichthys enoplos*
Mok-mok	*Hemisilurus scleronema*	Dalum	*Bagarius yarelli*

Tengkeloso (*Schlerophages formosus)*

Elang (*Datnoides quadrifsciatus*)

Parang (*Macrothiricthys microphirus*)



Sengarat (*Belodonticthys dinema*)

Fig. 1. Some freshwater fish species which are almost extinct in inland waters of Indonesia

Box 2: Important freshwater fish species with extremely decreasing populations			
Local Name	**Scientific Name**	**Local Name**	**Scientific Name**
Patin	*Pangasius* spp.	Tebengalan	*Puntius bulu*
Tapa	*Weellago leeri*	Jelawat	*Leptobarbus hoeveni*
Belida	*Chitala lopis*	Tilan	*Mastocembelus armatus*
Semah	*Tor douronensis*	Botia	*Botia macracanthus*
Betutu	*Oxyeleotris marmorata*	Kalui	*Osphronemus goramy*
Sidat	*Anguilla* spp.	Toman	*Channa mricroleptes*

Box 3: Introduced fish species in Indonesia open water bodies		
Species	**Location**	**Remarks**
O. mossambicus	Lake Toba (Nort Sumatera) in 1948	Established in 1952, became the dominating fish stock in this lake
T. pectoralis, C. batracus, H. temminckii, B. gonionotus	Lake Tempe (South Sulawesi) in 1937-1940	Yield during 1963-1975 averaged at 900 kg/ha/year
O. goramy, T. pectoralis	Lake Toba (North Sumatera) in 1920	Were not established
P. hypophthalmus, O. niloticus, B. gonionotus	Gajah Mungkur Reservoir (Central Java) in 1981-2003	Established in 1999/2000, in 2004 became dominating fish stocks in this reservoir

However, overfishing has been observed in many swampy forest areas that host capture fishing activities, *e.g.* in Kapuas, Barito, Musi, and the Lubuk Lampam flood plain areas. As a result, large size of some economically-important fishes have been overfished and become extinct (Utomo *et al*., 1993; Hoggarth and Utomo, 1994; Utomo, *et al*. 2003). Some of the most economically-important fishes that are now rarely found in Indonesia's flood plain areas are shown in (**Box 1**) with some almost extinct (**Fig. 1**). Some fish species with extremely decreasing populations are shown in **Box 2**, while some fish species that had been introduced in Indonesia's inland waters are shown in **Box 3**.

Fishing Gears and Methods

Many kinds of fishing gears are being operated in the inland open waters of Indonesia, especially in middle streams that comprise many flood plains. These include small gears, *e.g.* hook and line, cast net, pot traps, as well as large gears that capture large quantities of fish, *e.g.* barrier trap, filtering

Fig. 3. *Ngesek* (active barrier)

Fig. 2. *Tuguk* (filtering device)

device, active seine. The peak fishing season of *hampang*, *selambau* (filtering net), *tuguk* (**Fig. 2**), and *bubu* (pot trap), is at the end of the wet months (April-May) and the begining of wet months (October-November), catching the fishes that move from the flooded areas to rivers and from rivers to flooded areas, respectively. For the active barrier *ngesar* or *ngesek* (**Fig. 3**) and *beje* (pond trap), their peak fishing seasons is during the dry months (July-September) when the depth of swampy areas and river is shallow allowing the fish to be caught by these gear. Meanwhile, *jaring* (gill net), *pancing* (hook and line), and *jala* (cast net) could catch fish throughout the whole year.

More specifically, the fishing season of *hampang* (**Fig. 4**) set between river and swampy border takes place at the start of ebb tide (April-May). *Beje* which is operated in swampy areas and resembles a "pond trap," is made by digging a hole in the pond and setting a seine to catch fish the moment the water goes down. Its fishing season takes place when the water level is low or during the dry months (August-September). *Mangumpai* (seine with fish aggregating device (FAD)) is actively operated using a seine installed in the river during dry season.

Selambau is a wiring-formed cone pocket or bag (**Fig. 5**) and usually set in small rivers for catching migratory fishes, and its catch season is in April-May until the water level goes up in November. Fishing activities using *traps* in flood plain areas are very effective when the water level goes down (May-July) but the duration is not more than two weeks. The fishing gears dominating in the flood plain waters are traps, because fish would move according to the water fluctuation and traps are set to adopt with such water fluctuation.

Some gillnets such as "*rengge*" and "*lelangit*" with mesh sizes ranging from 1.0 inch to 7.0 inches, are operated in long rivers, *e.g.* Sambujur and Negara Rivers. *Lelangit* is operated horizontally with the surface waters for catching fishes that are taking oxygen from the air (*tilap*), while *merengge* is a kind of gillnet operated vertically in the waters blocking the fish migration. Fishing activities using *merengge* and *mangumpai* could be done in all seasons but considerable amount of catch could take place during the dry months when the water level is low. *Selambau*, *hampang*, *mangumpe* and *beje* are common in the flood plains of swampy areas. Fishing season of *hampang* and *selambau* is at the end of the wet months (April-June), blocking and barriering the fish that migrates from *lebak* or flood areas to rivers or lakes. At the end of the wet season, water from flood areas flows to deeper water bodies or to rivers and lakes. The fishing season of *selambau* takes place when the water goes down (from April to June) and the catch would be about 100 kg/day in one week but decreasing to 0.5-1.0 kg/day. The fish often caught by *selambau* includes *riu* (*Pangasius* spp.), *benangin*, *lais-laisan* (*Cryptopterus* spp.), and *biawan* (*Helostoma temminckii*).

Mangumpe and *beje* are generally operated in the dry months (July-September) when only the deeper water bodies (river, lake and *lebung*) would have water. *Beje* is designed to catch fish that exist in *lebung* or *beje*, whereas, *mangumpe* catches the fish from rivers or lakes. The measurement of *beje* varies between 10x2 m^2 and 20x2 m^2 as well as 20x3 m^2. The fish that is often caught by *beje* includes *haruan* or *gabus* (*Channa striatus*), *biawan*, *sepat siam* (*Trichogaster pectoralis*), *papuyuh* (*Anabas testudineus*) and *kepor* (*Pristolepis fasciatus*). The catch could vary from 200 kg/*beje*/season (prior to 1980) to 30 kg/*beje*/season (now). *Mangumpai* (*rempa*) measures 90 meters and can catch between 100 and 200 kg/day (duration of season is two weeks), but had been

Fig. 4. *Hampang* (barrier trap)

Fig. 5. *Selambau* (filtering net)

decreasing to 20-30 kg/day. The fish caught includes *sepat siam, haruan, papuyuh* and *grembes* (not an economical fish). Catching of *udang galah* or freshwater giant prawn (*Macrobrachium rosenbergii*) with hook and line is also very much affected by season and location. For example at Village Alow-Alow which is close to the mouth of Barito River, where in dry season salinity is 8.5 ppt, the catch could be 0.5 kg/person/day (5-7 hooks and lines), while in wet season where salinity = 0.15 ppt, the catch could be 1.0 kg/day (maximum). At Village Pulau Kembang close to Banjarmasin City, in dry season (salinity = 3.0 ppt), catch could be 1.0 kg/person/day (5-7 hooks and lines).

Catch Composition by Fishing Gears

***Hampang* (barrier with traps chamber)**

Baung (*Mystus nemurus*) is caught by *hampang*, the sizes of which vary from 10 to 34 cm. Small *baung* is easily caught because the slits of the woven bamboo vary between 1.0 and 2.5 cm, while big fish with hard dorsal and pectoral spiny fins could not penetrate the gear. Based on field observations, *Mystus nemurus* could mature after 20.0 cm in total length and 110 g body weight. If under 15.0 cm in total length and 40 g body weight, the fish will not be of economic value. *Baung* is useful when captured at the size which is over 20.0 cm in total length and 4 cm body height, the size at which the fish could reproduce and develop gonads in the waters.

Haruan (*Channa striata*) is caught by *hampang* at sizes between 6.0 and 41.0 cm length. The small fish is easily caught because of the bamboo slits are woven very closely (1.0-2.5 cm) but big fish with relatively large diameter of body fish could not penetrate the gear. From field observations, *haruan* at 13.0 cm total length, 35.0 g body weight, and 1.8 cm body height is usually caught. Gonadal maturity of the fish could be attained when fish reaches 18.0 cm total length, while the economical size of *haruan* (market size) is over 17.0 cm (Makmur, 2003; Kartamihardja, 1994). *Haruan* could also be caught when the size is over 18.0 cm total length, 80 g body weight and 2.5 cm body width.

Sepat siam (*Trichogaster pectoralis*) is caught by *hampang* at sizes between 13.0 and 18.0 cm. This fish reaches gonadal maturity when the size is over 12.0-13.0 cm in length and 25-30 g weight, at which size the fish also has marketable values (Utomo dan Ondara, 1987). *Sepat siam* under 12.0 cm is rarely caught by *hampang* because *sepat siam*'s body is thin and flat (*pipih*). At 12.0 cm length, its body is thick at 1.5 cm and no hard spiny fins so that the fish can easily penetrate the gear. Based on the field observations, *sepat siam* captured by *hampang* are generally adult fish with developed gonads.

***Beje* (seine with pond traps)**

Haruan is also caught by *beje* at sizes that vary from 14.0 to 40.0 cm in total length, while sizes smaller than 14.0 cm with body diameter of 1.9 cm, are rarely captured. This is because the mesh size of net is 1.5-2.0 cm, while the head and body of *haruan* is cylindrical (*silindris*) with no hard spiny pectoral or dorsal fins, so that it could easily pass the mesh size of the gear (pond traps).

Papuyuh (*Anabas testudineus*) is caught by *beje* when the size is between 8.0 and 20.0 cm. Based on field observations, *papuyuh* could mature when the size is over 11.0-12.0 cm in length and 30.0-40.0 g weight. Under 8.0 cm long and 15.0 g in weight, this species has no economic value. Small *papuyu* are easily caught by *beje* because the mesh size of nylon nets is 1.5-2.0 cm, while *papuyuh* with hard spiny on the dorsal and pectoral fins could not penetrate the nets. At 8.0-10.0 cm in length, its body height is 2.0-2.5 cm, and body thick of 1.2-1.5 cm. *Sepat siam* (*Trichogaster pectoralis*) is also caught by *beje* when the size is between 11.0 and 16.0 cm. However, it is more useful if the fish is captured when the size is approximately 12.0 cm in length and weighing 35.0 g to give the chance and opportunity of the species to mature in the water.

***Selambau* (filtering net)**

Sepat siam is caught by this gear when the size is 9.0-15.0 cm. Fishing activity using *selambau* does not give the chance for small species to develop and reproduce because fishes are usually caught at sizes under 12.0 cm. Besides, species under 10.0 cm in length and 15 g in weight do not have economical values. The other species which was caught by *selambau* is *sepat bujur* (*Trichogaster* spp.) when size is 5.0-9.0 cm in length, making *selambau* a non-selective gear. From field observations, *sepat bujur* could mature at 8.0 cm in length and over. In order to sustain the fishery resources in inland waters, small-sized fishes caught by the abovementioned fishing gears should be released back to the water to give them the chance to develop in the waters. For example, *baung* (usually caught when size is under 20.0 cm length), *haruan* (under 18.0 cm length), *papuyuh* (under 11.0 cm length), and *sepat siam* (under 12.0 cm length).

Production from Inland Fisheries

The fish production potentials from inland waters in Indonesia are not very high. In general, from its open waters the production potentials could be about 50-60 kg/ha/year. It has been estimated that production potentials from open waters in Sumatera could be 90-110 kg/ha/year, the open waters in Sentarum West Kalimantan at 125-150 kg/ha/year, while open waters at the eastern part of Wallace's line have low production potentials.

Based on the monitoring and interview of fishers with more than 5 years experience in fishing, the production trend has been decreasing every year by 10 to 15% because of increasing fishing activities and destruction of the ecosystem. The fish production from inland waters of Indonesia from 1997 to 2000 is shown in **Table 2**.

Table 2. Fish yield from inland waters of Indonesia (1997-2000) in metric tons

Year	Yield		
	Capture Fisheries (A)	Total inland fisheries (B)	A/B (%)
1997	304,258	968,660	31.4
1998	288,666	918,463	31.4
1999	327,627	1,074,647	30.5
2000	318,334	1,103,060	28.9
Mean	309,721	1,016,209	30.5

Thus, in order to increase the catch, the number of fishing gears operating in these waters should be decreased while the mesh size increased so that only large fishes could be caught instead of the small ones. In fact, many species of fish have extremely decreased, *e.g. bakut/betutu* (*Oxyeleotris marmorata*), *patin* (*Pangasius* spp.), *jelawat* (*Leptobarbus hoeveni*), *pipih/belido* (*Notopterus chitala*), and *tebirin/lais-laisan* (*Cryptopterus* spp.). The fish species which are now difficult to find include *belantau*/*parang-parang* (*Macrochirichthys macrochinus*) and *tangkeleso* (*Schlerophagus formosus*). The species that do not clearly decrease are those small sized fishes such as *seluang* (*Rasbora* spp.). This is because small fishes have potency to develop faster than large fishes (Effendie, 1997), besides large fishes are more intensively caught because of their high prices. *Haruan* and *baung* are examples of such large fishes, but the fishing exploitation (E) for both species could not be increased because the values of E of both species are already more than the optimum value of 0.50 (Gulland in Pauly, 1984), *i.e.* E= 0.57 for *Channa striata* and E= 0.71 for *Mystus nemurus*. While *sepat siam* is an example of a small fish, its fishing exploitation (E= 0.41) is still under the optimum value (E=0.50). Therefore, catching *sepat siam* could still be increased. Decrease in fish potency could be mainly caused by increasing fishing effort, while fishers continue to use dangerous fishing gears such as *stroom* (electric fishing). During the ocular observation, it was noticed that the swampy forests in freshwater areas serve not only as spawning ground but also as feeding and protecting grounds for the fish. However, many fishers reported that traces of chemical agents used to preserve wood, could still be observed in the waters causing deaths to many fish stocks that inhabit the waters.

Environmental Conditions in Fishing Areas

Many issues and concerns should be addressed in order to promote sustainable management of open water fisheries in Indonesia, especially in enhancing the quality of fishing in the country's inland open waters. These include sedimentation, enforcement of fishery laws and regulations, and pollution. Sedimentation in open waters has been occurring for years due to high exploitation of the forest, continued adoption of shifting agriculture, and to a certain extent, establishment of recreational resorts in the mountainous areas.

As a result, many small reservoirs in Java are now covered with sediments, and land is becoming non-productive while some places had been converted into urban areas. Pollution caused by industrial and domestic wastes is another problem, as exemplified in the case of the water quality of Solo River. In Cirata Reservoir, fish cage culture makes use of 25,000 units, which is 6 times more than the carriying capacity of only 4,000 units. Upwelling in the begining of rainy season usually causes fish mass mortality. Fishing activity in open waters is difficult to control, while illegal fishing activities (*e.g.* electric fishing, use of poison) are still rampant in spite of the enactment of the Law of Fisheries No.9 1985. Results of case studies conducted in Kapuas, Musi and Barito Rivers, indicated that the middle streams of these rivers have many flood plains and swampy forests that have potentials for increased fish production.

The important vegetations of swampy forests consist of *putat* (*Barringtonia acutangula*), *mentangis* (*Oxora mentangis*), *menyawai* (*Elacocarpus submonoceras*), and *melayak* (*Croton* spp). These vegetations sustain the function of the swampy forests as spawning, feeding and nursery grounds.

Pollution also seriously impacts on the survival of aquatic organisms. Results of a case study in Solo River in Java indicated that industrial and domestic wastes have caused heavy pollution of the water. Solo River now has high concentration of COD (1.0 – 127.5 mg/l), low oxygen (0.0 – 1.2 mg/l), and high fenol concentration (0.2 – 1.4 mg/l), among others. As a resuilt, stocks of economically important native fish species had been lost. Now, the River is inhabited by aquatic species that are not economical, *e.g. sapu sapu* (*Liposarcus pardalis*).

The socio-economic condition of inland fisheries in Indonesia

Educational attainment of fishers in Indonesia is mainly at the basic or elementary level but they have the ability to read and write. Many fishers take up informal education, such as courses in traditional fish processing. However, they are knowledgeable on and experienced in fishing methods, making fishing gears and fish processing for more than 10 years. The inland open water fishers in Indonesia are mostly traditional fishers who use traditional gears, most of which are made by themselves. Their methods of fishing used are based on their own experience. Based on the amount of time spent for catching fish, the fishers could be grouped into four, especially those coming from South Sumatera, namely: "*Pengemin*" Fishermen, "*Bekarang Tetap*" Fishermen, "*Bekarang Ttidak*

Box 4. Four groups of open water fishers

1. *Pengemin*" Fishermen: fishers who get the license to catch fish from the government and can access the area (lebak lebung) through auction which is held every year in South Sumatera. "Pengemin" fishermen are fulltime fishers.
2. "*Bekarang Tetap*" Fishermen: fishers who lease part of area to the "Pengemin" fishermen for one year and are full time fishers.
3. "*Bekarang tidak tetap*" fishermen: fishers who lease part of area to the "Pengemin" fishermen for specific time only and catch fish only for 3-4 months, *e.g.* they lease to catch fish with hook and line during flooding time (January-March). During low water condition (July-September) they lease an area to catch fish with long line or similar gears.
4. "*Sambilan*" Fishermen (Part-time fishermen): fishers who catch fish at their free time, and usually help "Pengemin" fishermen and receive money, *e.g.* they help Pengemin in dropping active seines at capturing time, helping pick the fishes when filtering device is used. These fishers are also classified as occasional fishermen.

Tetap" Fishermen; and "*Sambilan*" Fishermen or Part-time Fishermen (**Box 4**).

The distribution of inland open water fishers in Indonesia is shown in **Table 3**, which is likely not according to the open water areas but based on the population in an island. The total fish harvested from inland water fisheries may not be considerably high (1,016,209 metric tons/year), but inland capture fisheries production annually contributes about 30.5% (309,721 metric tons/ year) to the country's total production from inland capture fisheries.

Inland Fisheries Management System

Management of open waters through the establishment of fish reserves is being practiced in Indonesia even prior to the 14th century. In East Kalimantan, the King of Kutai in the early 14th century established three fish sanctuaries along the Mahakam River, namely: Danau Loakang, Batu Bumbun and Danau Gab (Sarnita *et al*., 2001). In North Sumatera, the former local dukes living around Lake Toba established sanctuaries for the endemic *batak* fish (*Neolissochilus* spp., *Tor* spp.). During the Dutch occupation period, more fish reserves were established.

At the present time, there are 131 fish reserves in open waters of the country. However, only few reserves remain in good condition and are well-functioning, such as Danau Mahligai Fishery Reserve and Taman Ciri Fishery Reserve in Jambi; Danau Tujuh in Upper Kapuas River, West Kalimantan; and *ikan kancra* (*Tor* sp., *Labeobarbus* sp.) reserves in Kuningan District, West Java. Nonetheless, little has been done in the management of open water habitats to improve the quality of fisheries in open water bodies. In 1932-1957, eradication of aquatic weeds (especially water hyacinth) in Rawa Pening, Central Java, was carried out. After the weed eradication, the fish yield in the reservoir increased from 3.5 kg/ha in 1931 to 7.0 kg/ha in 1943, and to 124.0 kg/ha in 1957 (Sarnita, 1971). In 1960, the aquatic weeds of Rawa Jombor, a small reservoir in Central Java, were also eradicated. As a result, fish production of the reservoir increased up to 600.0 kg/ha/year (Sarnita and Djajadiredja, 1968). In 1962-1964, aquatic weed control was carried out in open waters of Kalimantan, but such eradication scheme did not have any impact on the fish production of the said open waters (Sarnita, 1971). Another effort in habitat improvement was done in Jatiluhur Reservoir in 1970, where a cladoceran *Daphnia similis*, was introduced into the reservoir, and developed well until 1977 (Sarnita, 1983).

Management of capture fishery in inland waters in Indonesia until today has been carried out using the top-down management method, which is not very effective because the government body (either local or central government) plays a very important role in the management activities. The government makes fishing rules and other iinstruments, and also administers the implementation of the rules. Local fishers, people living surrounding the water bodies and other stakeholders play only small roles in the management system.

Conclusion

Indonesian inland open waters consist of tidal swampy areas (39.90 million ha), rivers and floodplain areas (11.95 million ha), and lakes and reservoirs (2.1 million ha). Open waters play very important role in making available nutritious food from fish, providing resources that increase fishers' incomes, increasing the original local's incomes, hosting numerous aquatic organisms, and maintaining environmental balance. In 2000, the total production from Indonesia's inland open water fisheries was around 306,600 mt or about 28% of the country's total inland fisheries production. The potential area for capture fisheries in open waters is estimated to be over

Table 3. Distribution of inland water fishers in Indonesia

Island	1997		1988		1999		2000	
	Full-time	Part-time	Full-time	Part-time	Full-time	Part-time	Full-time	Part-time
Sumatera	58,515	119,715	64,444	201,305	70,343	208,872	64,555	229,822
Java	52,844	76,254	10,234	11,687	8,145	9,240	8,751	116,371
Lesser Sunda	9,382	8,651	782	737	895	844	633	16,135
Kalimantan	50,653	94,725	51,220	78,398	54,624	91,858	54,286	85,908
Sulawesi	10,450	14,063	8,156	10,882	8,105	10,834	7,504	14,232
Moluccas & Western Papua	3,704	9,670	4,728	12,139	4,841	12,424	4,886	15,322
Total	**185,548**	**323,078**	**139,564**	**315,148**	**146,953**	**334,072**	**140,615**	**477,790**

Logging

Flood plain in swampy forest

Flood plain in middle stream

Industrial pollution near Solo River

10 million ha with potential production of about 1,028,250 - 1,150,300 mt, specifically in floodplain areas that have been known to provide high productivity. However, inland open waters remain common property and are subjected to sedimentation, pollution, and weak enforcement of fishery laws and regulations. As a result, fisheries production from the country's inland open waters has tendency to decrease, while some fish species are becoming extinct.

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The Shifting Habitat of Hilsa: River to Sea

M. Shahadat Hossain

Hilsa (*Tenualosa ilisha*) is one of the most economically-important fish species in Bangladesh, India, and Myanmar. To some extent, hilsa has also been found to inhabit the waters of Thailand, especially in the Andaman Sea as well as in waters in its eastern part extending as far as Malaysia, Indonesia, and Viet Nam (BOBLME & SEAFDEC, 2015). In view of the wide distribution of hilsa in Southeast Asia, the Southeast Asian Fisheries Development Center (SEAFDEC) and the Bay of Bengal Large Marine Ecosystem (BOBLME) Project of the Food and Agriculture Organization of the United Nations, entered into an agreement for a technical exchange to enhance the capacity of scientists from Myanmar and Thailand, as well as their understanding of the biology and life stages of this species. This article will article will not discuss the outputs of the BOBLME-SEAFDEC Project, but will focus on the status of hilsa production in Bangladesh to understand the shifting phenomenon of the habitat of this species from the rivers to the marine waters.

Since the 18th century, administrators, philosophers, naturalists and scientists have been fascinated by the impressive size of hilsa, its euryhaline behavior and capability to move through extensive distant migration routes between marine feeding grounds and riverine spawning grounds. In Bangladesh, many rivers like the Ganges, Brahmaputra, Padma, Meghna, Hoogly, Irrawaddy, Mahananda, Godavari, Krishna, and Cauvery have been characterized as the major source for the riverine catch of hilsa, while the Bay of Bengal has recently been recording considerable quantities of marine catch of hilsa. The riverine contribution to the country's total hilsa production in 1950-60s was 94% while the marine catch contributed only 6%. This trend has however been reversed in recent decades with 72% comprising the marine catch of hilsa and 28% from riverine catch. Unplanned water control structures in the upstream rivers, disruption of migration routes, degradation of habitats, indiscriminate exploitation of juveniles and broodstocks, and increased fishing pressure in the near shore and estuarine areas with efficient gears have been attributed to have contributed to the decline of the riverine catch of hilsa. In the Meghna River estuary of Bangladesh, which has been reported to account for the highest hilsa landing in recent decades, drift gill, fixed gill and seine nets have been used to catch hilsa. As the global market opportunity for hilsa has expanded to the Middle East, Europe, USA, Canada, Japan, and Australia, the demand for hilsa has been increasing. Therefore, management of its fisheries is something that should be dealt with by countries in cooperation with transboundary countries where this species is known to also inhabit. Lessons on the reasons for the shifting habitats of hilsa could be learnt from this article.

The Habitats of Hilsa during the 18th Century

Fish habitat is a shifting mosaic over years to decades, and even centuries (van der Nat *et al*., 2003). Fish selects habitats that balance its demand for food with energetic costs, predation risk, and competition (Werner *et al*., 1983; Fausch, 1984; Hubert *et al*., 1994). The temporal fluctuations, *e.g.* daily, monthly, annually, decadal and centurial, of the habitats' ecological characteristics, *e.g.* temperature, salinity, dissolved oxygen, acidification, dissolved materials and water flow, affect the extent and quality of the fish habitats. Historically in Bangladesh, hilsa fishery used to dominate in the upstream rivers of the Ganges, Brahmaputra, Padma, Meghna, Hoogly, Irrawaddy, Mahananda, Godavari, Krishna, and Cauvery (**Fig. 1**). Recently however, hilsa is known to inhabit more in the marine waters of the Bay of Bengal.

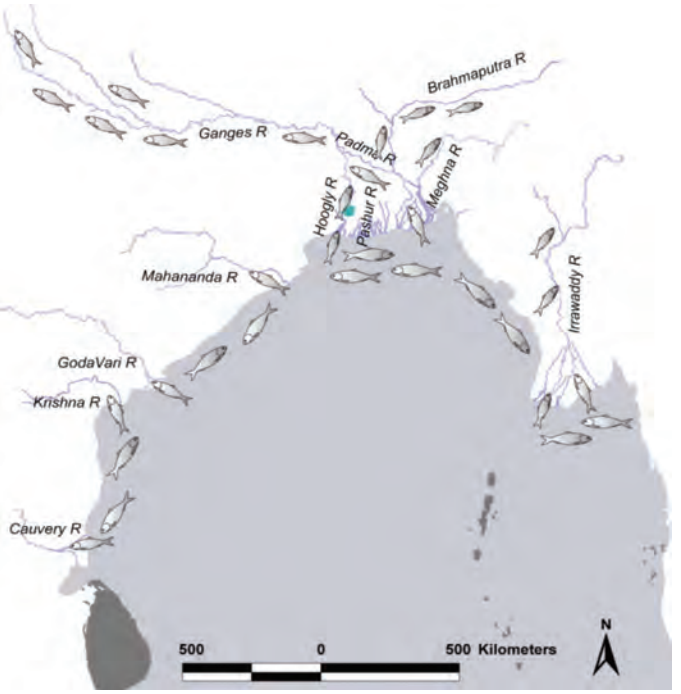

Fig. 1. Distribution of hilsa during the 18th century in the major river basins of the Bay of Bengal

Many researchers and scientists have established that the range of hilsa migration used to cover a distance of about 1920 rkm (river kilometer) from the Bay of Bangal to Agra and Delhi through the Ganges River (Hora, 1941; Quereshi, 1968), 825 rkm up to Mandalay through the Irrawady River (Day, 1873), 780 rkm up to the Tezpur of the Brahmaputra River (Pillay and Ghosh, 1958; Rao and Pathak, 1972), 410 rkm of Hooghly (Day, 1889; Jones, 1957; BOBP, 1985), 50

rkm in the Godavari (Chacko and Ganapati, 1949; Pillay and Rao, 1963; Rao, 1969, Rajyalakshmi, 1973), 275 rkm in Meghna (Quereshi, 1968; Shafi *et al*., 1978), and 420 rkm in Padma (Quereshi, 1968).

Through the years, it has been noted that the construction of barrages and dams without fish pass on various rivers had reduced the river range of the hilsa (Jafri, 1988). Although fish ways or fish passes had been constructed in the weir across the Cauvery River at Coleroon (Wilson, 1909) and at the Mahanadi River at Cuttack (Southwell and Prashad, 1918), but it was observed that such facilities have failed to function in sustaining the migration of hilsa. As a consequence, hilsa had dispersed in the wider areas of the northern part of the Bay of Bengal, thus, the significant increase of the marine catch of hilsa in Bangladesh, Myanmar and India since 1990s (FAO, 2015; DoF, 2014; Hossain *et al*., 2014).

Historical Production of Hilsa in Bangladesh

Records have shown that the riverine contribution of hilsa from 1956-1957 to 1961-1962 was 94% and the marine contribution was only 6% (Ahsanullah, 1964). In contrary, from the total catch of hilsa landing in Bangladesh during 2012-13 of 351,000 metric tons (MT), 72% came from marine catch and 28% from riverine catch (DoF, 2014). Similarly, of the total hilsa catch of 18,593 MT in India during 2013 (FAO, 2015), 78% was represented by marine catch and 22% from riverine catch (**Fig. 2**).

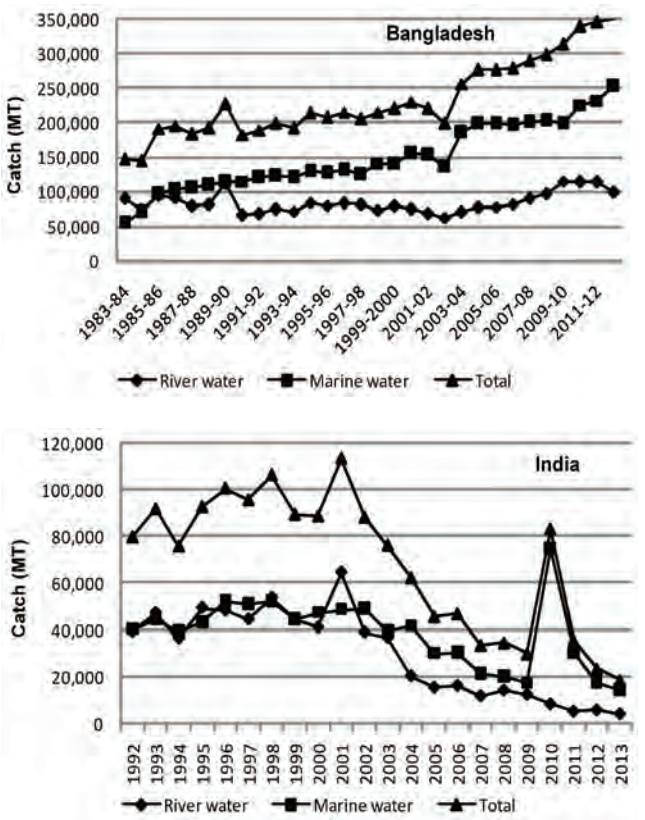

Fig. 2. Hilsa catch from river and marine waters in Bangladesh (above) and India (below)

Source: DoF, 2014; FAO, 2015

The near shore and offshore waters of the Bay of Bengal have been known as the major source for the marine catch of hilsa. Of the total catch of hilsa, the rivers of Meghna, Padma and Pashur in Bangladesh contribute 21% to the hilsa landing, while the Irrawaddy River in Myanmar contributed 3% to hilsa catch and the river of Hoogly in India accounted for only 1% of the hilsa landing. It is assumed that the marine catch of hilsa represents 74%, where the riverine catch accounts for the remaining 26% (**Fig. 3**). It has been reported that the unplanned water control structures in the upstream rivers associated with heavy siltation, degradation of habitats (spawning, feeding and nursing), disruption of migration routes, indiscriminate exploitation of juvenile and brood, and increased fishing pressure in the near shore and estuarine areas with mechanized vessels and efficient gears have contributed to decline of the riverine hilsa catch (Islam *et al*., 1986; Haroon, 1998).

Wav Forward

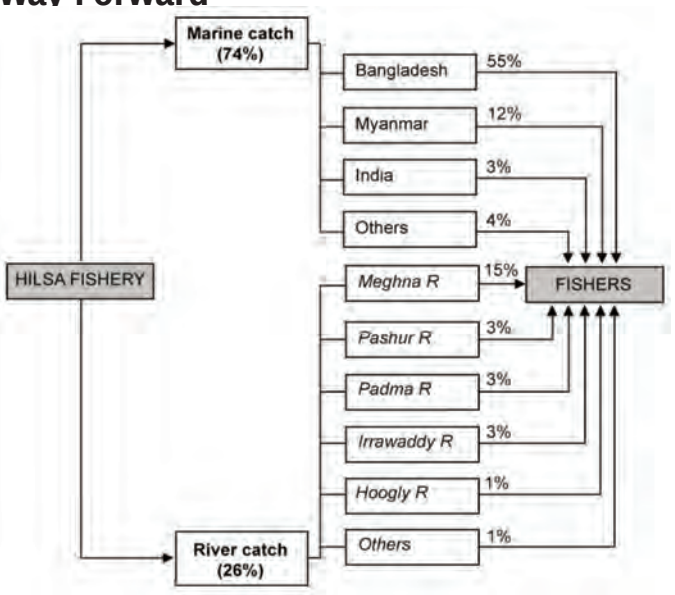

Fig. 3. Present status of marine and riverine catch of hilsa

Typically, hilsa is exploited by deploying drift gillnet, fixed gillnet or seine net in the Meghna River estuary and adjacent waters. The gear characteristics depend on the water current, depth, tidal phase as well as seasonality, and weather condition, but while the drift gillnet moves with the water current, the fixed gillnet is set in specific locations of the river bottom. Meanwhile, the seine net encircles the shallow region of the waters to trap schools of hilsa (**Fig. 4**).

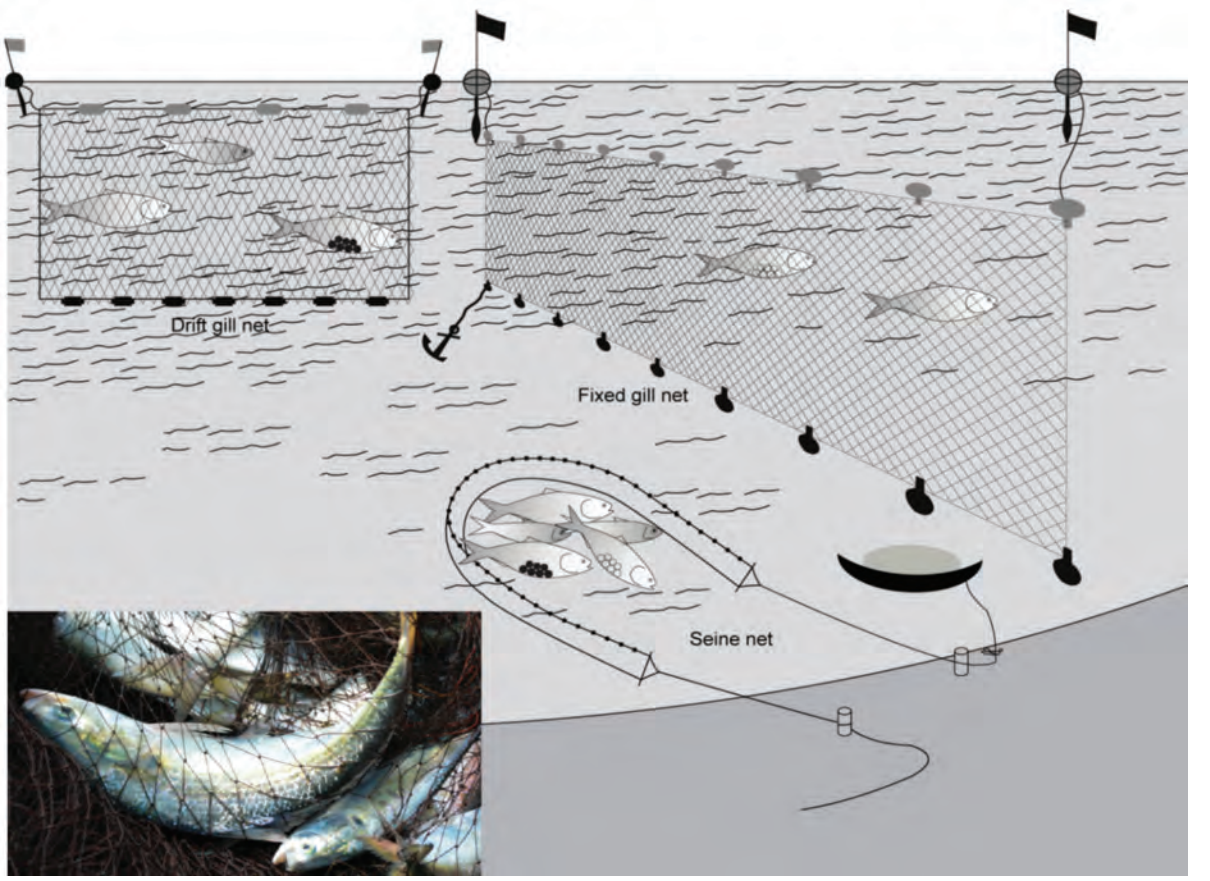

Fig. 4. Hilsa fishing gears in the Meghna River estuary;
Inset: silver shinny live hilsa with transparent watery slime and pleasant odor

The global market opportunity for hilsa in Middle East, Europe, USA, Canada, Japan and Australia (**Fig. 5**) has resulted in increased demand for high quality hilsa. Therefore, while the hilsa resource is not yet over-exploited, it is necessary that management measures should be established for the sustainable utilization of this economically important resource. In this connection, it would be worthwhile to initiate a data-prospecting and data-recovery effort for the catch composition of hilsa since 1950s in the Bay of Bengal and adjacent rivers. The analysis of these data is likely to provide some valuable and original insights into hilsa spatial dynamics, as unplanned water control structures on different rivers could have been instrumental in the remarkable variations in the abundance and distribution of hilsa.

In addition, more essential aspects need to be explored, which could include: where the hilsa disperse after leaving the freshwater ecosystem and where hilsa go after entering

Fig. 5. Hilsa trade and distribution to global destinations

the river; whether hilsa exhibits homing fidelity; and whether hilsa is semelparous or iteroparous by nature or if both patterns exist in the population. Moreover, studies on the occurrence of diseases and parasites in hilsa should also be extensively carried out.

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CALENDAR OF EVENTS

Date	Venue	Title	Organizer(s)
2017			
11 Sep-16 Dec	Online course	Distance Learning Course on Principles of Health Management in Aquaculture (AquaHealth Online)	SEAFDEC/AQD
12-14 September	Bangkok, Thailand	Regional Technical Consultation on Evaluation of Implementation and Utilization of the RFVR 24 Meters in Length and Over to Reduce IUU Fishing in ASEAN	SEAFDEC/TD
13-14 September	Thailand	Training of Trainers on Ecosystem Approach for Fisheries Management (EAFM) for DOF Thailand	SEAFDEC/TD
12-14 September	Kuala Lumpur, Malaysia	Core Expert Meeting on Purse Seine Fisheries	SEAFDEC/MFRDMD
18-27 September	Iloilo, Philippines	Training Course on Mangrove Crab Nursery & Grow-out Operations	SEAFDEC/AQD
25-26 September	Manado, Indonesia	CTI-CFF/USAID Inception Workshop: Building-up Regional Catch Documentation and Traceability (CDT) System and Advancing Fisheries Management for Strengthening Food Security in Coral Triangle Region	CTI-CFF and USAID-Oceans
26-28 September	Bangkok, Thailand	Experts Workshop on Regional Approach for the implementation of FAO Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries: Human rights-based approach and gender equitability	SEAFDEC/ Secretariat
26-29 September	Vung Tau, Viet Nam	On-Site Training on Elasmobranch Taxonomy and Biology	SEAFDEC/MFRDMD
10-12 October	Singapore	18th Meeting of Information Staff Program (ISP)	SEAFDEC/Sec & MFRD
15-20 October	Brunei Darussalam	2nd Training Course on electronic ASEAN Catch Documentation Scheme (eACDS)	SEAFDEC/ Secretariat
17-18 October	Phnom Penh, Cambodia	Technical Meeting of the Joint Working Team for Fisheries Management between Cambodia and Viet Nam	SEAFDEC/ Secretariat
23-27 October	Binangonan, Philippines	Training Course on Catfish Hatchery & Grow-out Operations	SEAFDEC/AQD
24-27 October	Rome, Italy	9th Session of the FAO Sub-Committee on Aquaculture	FAO
31 Oct -2 Nov	Pattaya, Thailand	Sub-regional Consultation on the Development of MCS in the Gulf of Thailand	SEAFDEC/ Secretariat
6-11 November	Ranong Province, Thailand	Regional Training Course on Essential Ecosystem Approach to Fisheries Management (E-EAFM)	SEAFDEC/TD
7-9 November	Kuala Lumpur, Malaysia	4th Scientific Working Group on Neritic Tunas Stock Assessment and Advance Training Course on Risk Assessment of Longtail Tuna and Kawakawa in the Southeast Asian Waters	SEAFDEC/MFRDMD & Secretariat
14-16 November	Bangkok, Thailand	APFIC/FAO Regional Consultation "Building Climate Resilient Fisheries and Aquaculture in the Asia-Pacific Region"	APFIC
16-17 November	Bangkok, Thailand	3rd Sub-regional Consultative Workshop of the Northern Andaman Sea/Myeik Archipelago	SEAFDEC/ Secretariat
21-22 November	Bangkok, Thailand	Sub-regional Consultative Meeting on the Joint Fisheries Management Around the Southern Andaman Sea	SEAFDEC/ Secretariat
21-23 November	Kuala Lumpur, Malaysia	2nd Regional Technical Consultation on Promotion of the ASEAN Guidelines for Preventing the Entry of Fish and Fishery Products from IUU Fishing Activities into the Supply Chain	SEAFDEC/MFRDMD
21-24 November	Myanmar	Workshop on Development of the Fisheries Management Plan for Thahton Township, Mon State, Myanmar	SEAFDEC/TD
21-30 November	Binangonan, Philippines	Training Course on Community-Based Freshwater Aquaculture for Remote Rural Areas of Southeast Asia	SEAFDEC/AQD
27-29 November	Bangkok, Thailand	40th Meeting of SEAFDEC Program Committee (PCM)	SEAFDEC/Sec & MFRD
30 Nov-1 Dec	Bangkok, Thailand	20th Meeting of the Fisheries Consultative Group of the ASEAN-SEAFDEC Strategic Partnership (FCG/ASSP)	SEAFDEC/ Secretariat
4-6 December	Bokeo, Lao PDR	Training on Ecosystem Approach to Fisheries Management (EAFM) in Lao PDR	SEAFDEC/TD
18-22 December	Kampot, Cambodia	Training on Ecosystem Approach to Fisheries Management (EAFM) in Cambodia	SEAFDEC/TD

Southeast Asian Fisheries Development Center (SEAFDEC)

What is SEAFDEC?

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

Mandate

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

Objectives

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

SEAFDEC Program Thrusts

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


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The second prize drawing winner, *Thant Zin Htite*, from the national drawing contest in Myanmar

National Drawing Contests were organized in all ASEAN-SEAFDEC Member Countries as part of the preparatory process for the ASEAN-SEAFDEC Conferene on Sustainable Fisheries for Food Security Towards 2020 "Fish for the People 2020: Adaptation to a Changing Environment" held by ASEAN and SEAFDEC in June 2011 in Bangkok, Thailand, in order to create awareness on the importance of fisheries for food security and well-being of people in the region.