

FISH for the PEOPLE

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Ensuring Sustainable Use of Aquatic Resources while Boosting the Social Well-being in Fishing Communities of Southeast Asia



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Editorial

The seven-year technical and financial support provided by the Swedish Government to SEAFDEC facilitated the implementation of the Project “Fisheries and Habitat Management, Climate Change and Social Well-being in Southeast Asia” starting in 2013. Known as the SEAFDEC-Sweden Project, its implementation which reached the final leg in 2019 has the overall objective of achieving sustainable utilization and management of the aquatic resources and reducing vulnerability to climate change by fishing communities in the ASEAN Member States (AMSs). Such goal had been achieved through the Project’s adherence to its three output objectives: Capacity Built for Integration of Fisheries and Habitat Management and Adaptation to Climate Change; Capacity Built and System Improved for the Management of Fishing Capacity (monitoring, record and control); and Capacity Built and Policy Development Process Improved for Drafting and Implementation of Regional and Sub-regional Agreements. Several cross-cutting issues had also been addressed, especially those related to gender and labor aspects, local capacity-building, diversifying livelihoods, enhancing the social well-being, and strengthening the cooperation among the Southeast Asian countries. Although the Project embraced four sub-regions in Southeast Asia, *i.e.* the Andaman Sea, Gulf of Thailand, Mekong River Basin, and the Sulu-Sulawesi Seas, specific sub-regional focus was given to strengthening of the cooperation around the Gulf of Thailand and Andaman Sea, considering that the other two sub-regions had already been covered by collaborating partners.

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Call for Articles

FISH for the PEOPLE is a policy-oriented special publication of SEAFDEC. Now on its 18th year, the Publication is intended to promote the activities of SEAFDEC and other relevant fisheries concerns in the Member Countries. We are inviting contributors from the SEAFDEC Departments, Member Countries, and partner organizations to submit articles that could be included in the forthcoming issues of the special publication. The articles could cover fisheries management, marine fisheries, aquaculture, fisheries postharvest technology, fish trade, gender equity in fisheries, among others. Written in popular language and in layman’s terms for easy reading by our stakeholders, the articles are not intended to provide detailed technical and typical scientific information as it is not a forum for research findings. Please submit your articles to the Editorial Team of Fish for the People through the SEAFDEC Secretariat at fish@seafdec.org. The article should be written in Microsoft Word with a maximum of 10 (ten) pages using Times New Roman font 11 including tables, graphs, maps, and photographs.



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

During the course of its implementation, the SEAFDEC-Sweden Project had successfully concluded several activities with significant achievements, *e.g.* sustainable management of neritic tunas and other transboundary aquatic resources/stocks, management of fishing capacity and combating IUU fishing, establishment of MCS networks, strengthening gender integration in the fisheries sector, addressing the importance of small-scale fisheries. The Project activities had been planned and carried out with the Ecosystem Approach to Fisheries Management (EAFM) at their backdrops. Furthermore, discussions among the countries concerned were part and parcel of the Project to ensure that several areas of mutual interest were being addressed and fostered through enhanced sub-regional cooperation that were achieved by the frequent bilateral dialogues among the countries in the sub-regions. The experiences obtained and lessons learned from the implementation of the Project had been shared through the various fora as well as through the different issues of this SEAFDEC Special Publication *Fish for the People*. Moreover, the Project outputs had also been encapsulated into Key Messages to serve as guide for SEAFDEC, the ASEAN, governments of the AMSs, and the Project's partner organizations in building on the Project results and sustaining its initiatives beyond 2019.

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

The contents of this publication do not necessarily reflect the views or policies of SEAFDEC or the editors, nor are they an official record. The designations employed and the presentation do not imply the expression of opinion whatsoever on the part of SEAFDEC concerning the legal status of any country, territory, city, or area of its authorities, or concerning the legal status of fisheries, marine and aquatic resource uses and the delimitation of boundaries.

Enhanced Fisheries Sector Capability for Sustainable and Socially-equitable Resources Management: A legacy of the SEAFDEC-Sweden Project for Southeast Asia

Pattaratjit Kaewnuratchadasorn, Virgilia T. Sulit, and Nualanong Tongdee

The Government of Sweden has been supporting the efforts of the Southeast Asian Fisheries Development Center (SEAFDEC) in pursuing the sustainable development and management of fisheries in the Southeast Asian region. During 2003-2007, the Swedish International Development Cooperation Agency (Sida) through the Swedish Board of Fisheries collaborated with SEAFDEC for the implementation of the *Regional Guidelines for Responsible Fisheries in Southeast Asia: Responsible Fisheries Management* in the ASEAN Member States (AMSs) through the conduct of capacity building activities and regional consultations. This led to the unfolding of three thematic priorities to be pursued, for the sustainability of the fisheries of Southeast Asia. These thematic priorities are: (1) management of fishing capacity for combating illegal, unregulated and unreported (IUU) fishing; (2) strengthening of local fisheries management to adapt to climate change and improve social well-being, and (3) integration of fisheries into habitat management. With the main objective of advancing the sustainable management of fishing capacity in the region, a subsequent collaboration between Sida and SEAFDEC (2008-2012) had evolved which was promoted through regional and sub-regional

arrangements, and which hereinafter laid the foundation for the development of four sub-regions in Southeast Asia, namely: the Andaman Sea, Gulf of Thailand, Mekong River Basin, and the Sulu-Sulawesi Seas. Building therefore upon the progress of the Sida and SEAFDEC arrangements, a new arrangement (2013-2019) was forged between SEAFDEC and the Government of Sweden through the Swedish Embassy in Bangkok, Thailand for the promotion of regional cooperation and development, and implementation of sub-regional agreements on fisheries and environmental management, with the fishers in coastal and inland communities as the target stakeholders. Dubbed as the SEAFDEC-Sweden Project, it had pursued activities that aim to enhance the integration of fisheries and habitat management, e.g. adaptation to climate change and improving social well-being in coastal and inland communities. The collaborative arrangements between SEAFDEC and the Government of Sweden therefore had provided opportunities for fishers in the coastal communities of the region to enhance their capability in aggressively pursuing sustainable management of the fishery resources, the adaptive norms to changes in the climate, and improvement of their social well-being.

At the outset, SEAFDEC has been mandated among others, to “train fisheries technicians of the Southeast Asian countries,” a function which SEAFDEC has championed since its establishment in 1967 up to the present. Thus, in all its undertakings, SEAFDEC always makes sure that human resource development is promoted in the Southeast Asian region, and this was also true with the SEAFDEC-Sida and SEAFDEC-Sweden Projects. At SEAFDEC, human resource development focuses on the organizational effectiveness of technology development, verification, and dissemination through meetings and consultations to enhance feedback mechanisms among the concerned stakeholders. It also comes in the form of professional development of fisheries technicians and officers through formal training as well as on-site and practical sessions, to enable them to gain knowledge on the advances in fisheries technologies and obtain the necessary skills for the promotion of such technologies, taking into consideration the technicians’ and officers’ varying capacity gaps.

The Regional Consultation on Human Resource Development in Fisheries Management organized by SEAFDEC in 2004 pointed towards the need to promote human resource development in the Southeast Asian region for the effective

integration of habitat and fisheries management (Torell, 2004). Moreover, the regional consultation also came up with specific recommendations that in the human resource development processes, focus should also be given on the adoption of the concepts of co-management and ecosystem approach to fisheries management, habitat rehabilitation, and resources evaluation among others. Based on such recommendations therefore, the collaborative projects between SEAFDEC and the Government of Sweden had taken up “the improvement of the social well-being and environmental health in the region’s fisheries sector through the integration of habitat and fisheries management,” as their over-arching goals.

SEAFDEC-Sida Project

In 1998, SEAFDEC embarked on a program for the Regionalization of the Code of Conduct for Responsible Fisheries (RCCRF) to ensure the effective and efficient implementation of the global Code of Conduct for Responsible Fisheries (CCRF) which was adopted in 1995. The RCCRF had two main components, namely: formulation and dissemination of the regional guidelines on responsible fisheries; and promotion of human resource development towards sustainable fisheries management.

Human resource development on fisheries management

The involvement of the SEAFDEC-Sida Project in programs and activities of SEAFDEC had focused on the second component of the RCCRF, *i.e.* human resource development for the sustainable management of fisheries. Upon the completion of the series of Regional Guidelines by SEAFDEC, promoting the implementation of the Guidelines in the Southeast Asian region was necessary in order that the countries would be able to develop their respective national frameworks for the adoption of the global CCRF. It was in this aspect that SEAFDEC worked with the Swedish International Development and Cooperation Agency (Sida) to carry out the activity “Human Resource Development for Fisheries Management in the ASEAN Region” from 2003 until 2007, through series of meetings and consultations meant to address the emerging issues and concerns in the region’s fisheries sector. In one of those fora, issues that confront the fisheries sector of the region were identified, the major ones of which centered on the need to strengthen the sustainable management of the fishery resources through the management of fishing capacity and reduction of over-capacity. In addressing such issue, the project initiated the Promotion of Regional Cooperation in Fisheries Management and Management of Fishing Capacity (Wanchana, 2007), paving the way for the regional movement that laid the foundation for the development of the Regional Plan of Action for the Management of Fishing Capacity (SEAFDEC, 2017).

Arrangements for sub-regional management of transboundary fishery resources

The Southeast Asian region is endowed with vast water resources, not only marine waters but also inland water bodies. Considering that most of the water bodies in the Southeast Asian region are shared by two or more countries, the promotion of Regional Fisheries Management Strategies for Southeast Asia was therefore initiated to provide the framework for better management of the transboundary resources and the platform for cooperation within the region to comply with the



Figure 1. Map of Southeast Asia showing the four sub-regions that had been involved in the collaborative project between SEAFDEC and the Government of Sweden

requirements called for in various international instruments, as well as facilitate the implementation of international standards and procedures, and related requirements for sustainable fisheries management.

During the series of consultations organized by the SEAFDEC-Sida Project for the promotion of sustainable management of the region’s transboundary resources, it was agreed that the regional management mechanism should be supported by arrangements at sub-regional levels to address area-specific issues, such as those that concern the habitats, transboundary aquatic resources and potential conflicts (Ekmaharaj *et al.*, 2009). Thus, the sub-regional arrangements for the Project that had been agreed upon, should focus on four sub-regions, namely: the Gulf of Thailand, Andaman Sea, Sulu-Sulawesi Sea, and the Lower Mekong River Basin (**Figure 1** and **Box 1**).

Box 1. Development potentials of the four sub-regions of Southeast Asia covered by the SEAFDEC-Sida and SEAFDEC-Sweden Projects (adapted from Ekmaharaj *et al.* (2009))

Gulf of Thailand: The Gulf of Thailand (GOT) has high fishery resource potentials because of its shallow topographic bottom (less than 85 meters deep) features that forms the Gulf into a large basin, and the many important rivers that bring down nutrients into the Gulf. Fisheries in the GOT are diverse with small-scale coastal and large-scale fishing operations in the offshore areas. However, the absence of fisheries management and the practice of open access fisheries had rendered the resources especially the demersal resources, towards depletion, as all types of fishing in the Gulf have caused high pressure on the resources. In addition, the depleted resources gave rise to the increasing conflicts between groups of fishermen, occurrence of IUU and trans-boundary fishing, which in turn reduced the opportunities for domestic and export markets that impacted on the livelihoods of fishers.

Andaman Sea: The Andaman Sea faces and connects the Indian Ocean, but is almost semi-enclosed due to the Andaman and Nicobar Islands that are “fringing” the Andaman Sea in the eastern part. The geographic and bottom features are quite distinct from that of the Gulf of Thailand. With an area that includes a large continental shelf in the northern part of Myanmar and a deep basin down to 2,000 m in the central part of the Andaman Sea, many rip-currents occur where two water masses meet producing an abundance of small pelagic fishes in its offshore waters. This area therefore has great biodiversity on its continental shelf and continental slopes as well as further offshore. Many commercial fish species thrive on the continental slopes where the depth varies between 150-300 m, and there is an abundance of fish species in the Ayeyarwaddy Delta. Seasonal changes such as the northwest and southeast monsoons are beneficial and could be taken advantage of in order to reduce the rate of overexploitation and to build up conservation measures to allow the fish stocks to recover. As fishing activities could practically stop during the southeast monsoon, this could be taken as an opportunity to promote closed seasons. Considering the abundance of tuna resources in the Andaman Sea and the potentials of tuna fisheries in the Thai EEZ, exploring new tuna fishing grounds could be initiated, and developing deep sea fisheries on the continental slopes from 200-800 m could be planned. Nonetheless, the potentials and recovery rates of deep sea resources in the Andaman Sea are not yet fully known. Therefore, there is a general need to closely monitor new developments in the Andaman Sea to ensure the long term sustainable utilization of its fishery resources.

Box 1. Development potentials of the four sub-regions of Southeast Asia covered by the SEAFDEC-Sida and SEAFDEC-Sweden Projects (adapted from Ekmaharaj *et al.* (2009)) (Cont'd)

Sulu-Sulawesi Seas: Embracing the Banda Sea, Molucca Sea, Flores Sea, and Celebes Sea, the Sulu and Sulawesi Sea sub-regional area has great biodiversity in terms of coastal and offshore resources. The topography of its bottom indicates that almost 80 % of the sea areas are deep, with depths that range from 200 to 5,000 m. Its coastal areas are not suitable for trawling therefore demersal resources are underexploited although many fishing gear such as purse seine and ring-net are being utilized to exploit the small pelagic fishery resources, such as: neritic tunas, round scads and mackerel. Opportunities for future fisheries development in this sub-regional area could include exploring the potentials of deep sea fisheries where oceanic squid is also one of the potential resources. Nevertheless, the important pelagic fish species in this sub-regional area are straddling and highly migratory, therefore joint approaches to the management of their fisheries should be considered.

Lower Mekong River Basin: As one of the world's most productive freshwater bodies with an estimated annual fish production of 2.5-3.0 million mt, the Lower Mekong River Basin (LMB) is mainly floodplain where riverine fisheries using a great variety of fishing gear are practiced and where there is a very high involvement of rural people and farmers (part-time or full-time) in the fishing activities. Critical for the reproduction of fish is the seasonal changes in the monsoon and the importance of annual floods. The threat to the resource is more from infrastructure development rather than the fisheries itself, as this could affect the flooding patterns. The Mekong River Commission (MRC) was established "for the sustainable development of the Mekong River Basin" with Cambodia, Lao PDR, Thailand, and Vietnam that border the LMB as signatories. Fisheries management arrangements in the LMB are being promoted by MRC, including the use of fishing quota for the giant catfish (*Pangasianodon gigas*).

Thus, sub-regional arrangements had been sustained towards promoting sustainable fisheries management as well as managing fishing capacity to combat IUU fishing in the region (Awwaluddin *et al.*, 2011). More specifically, cooperation among the various stakeholders involved in the sub-regional arrangements had been consolidated for the development and/or improvement of Monitoring, Control and Surveillance (MCS) mechanisms for the Southeast Asian region which include improvement of port monitoring through enhanced vessel registration and licensing, improved vessel record and inventory, and strengthened MCS networking, especially among the transboundary countries. In the course of attaining such goal, capacity building activities had been organized to ensure that the countries would enhance their capability to promote sustainable fisheries management and combat IUU fishing.

SEAFDEC-Sweden Project

Boosting its support to the regional actions of the ASEAN Member States (AMSs) in addressing the challenges in fisheries and habitat management, the Government of Sweden provided financial support to SEAFDEC for the seven-year Project "Fisheries and Habitat Management, Climate Change and Social Well-being in Southeast Asia," better known as the "SEAFDEC-Sweden Project," undertaken from 2013 to 2019. With the goal toward "Sustainable use of aquatic resources and reduced vulnerability to climate change by coastal and rural (fishing) communities in the AMSs," the Project focused on strengthening capacity among the AMSs on management of fisheries and habitats, management of fishing capacity and combating IUU fishing through regional and sub-regional cooperation and on-site cooperation with regional and national partners for a broader coverage. The Project covered the four sub-regional areas indicated in **Box 1**, *i.e.* Gulf of Thailand, Andaman Sea, Sulu-Sulawesi Sea, and Lower Mekong River Basin, but the specific sub-regional focus was mainly given to strengthening of the cooperation around the Gulf of Thailand, and Andaman Sea (SEAFDEC, 2019).

The main reason for such arrangement was to avoid duplication of efforts considering that in the Lower Mekong River Basin (LMB), the Mekong River Commission (MRC) has been carrying out sustainable fisheries management activities. Meanwhile, in Sulu-Sulawesi Seas, the USAID-Oceans as well as the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF) are carrying out relevant activities, so that the SEAFDEC-Sweden Project collaborated with such agencies for the promotion of sustainable fisheries in these sub-regions. With the MRC, the SEAFDEC-Sweden Project facilitated the conduct of capacity building activities for the relevant stakeholders in the LMB, especially on the Ecosystem Approach to Fisheries Management (EAFM) towards improved management of fisheries and habitat integration. The Project also worked with the USAID-Oceans and the CTI-CFF in conducting stock studies of transboundary species in the Southeast Asian waters and other relevant activities. Through the Project, coordination and cooperation with international and regional organizations, other projects and partners had been enhanced, considering that partnership had always been the central element in the Project implementation strategy.

Output Objectives of the SEAFDEC-Sweden Project and corresponding activities

With the overall objective of achieving sustainable use of aquatic resources and reducing vulnerability to climate change by fishing communities in the AMSs, the SEAFDEC-Sweden Project carried out activities towards achieving three output objectives shown in **Box 2**. The Project however, went beyond these specific objectives to address several

Box 2. Output objectives of the SEAFDEC-Sweden Project and the corresponding activities towards achieving the objectives
<p>Output objective 1: Capacity built for integration of fisheries and habitat management and adaptation to climate change</p> <ul style="list-style-type: none"> • Sustainability of transboundary species through the implementation of the Regional Plan of Action on Sustainable Utilization of Neritic Tunas in the ASEAN Region (RPOA-Neritic Tunas) • Management of transboundary resources/stocks through sub-regional approaches • Improving awareness and enhancing capacity on Ecosystem Approach to Fisheries Management
<p>Output objective 2: Capacity built and system improved for the management of fishing capacity (monitoring, record and control)</p> <ul style="list-style-type: none"> • Combating IUU fishing and management of fishing capacity • Monitoring of fishing efforts through enhanced traceability of fish and fishery products • Supporting the establishment of Monitoring, Control and Surveillance (MCS) Networks
<p>Output objective 3: Capacity built and policy development process improved and support drafting and implementation of regional and sub-regional agreements</p> <ul style="list-style-type: none"> • Strengthening the sub-regional cooperation in target sub-regions • Coordination with other organizations and projects • Enhancing coordination with the ASEAN countries through the Regional Fisheries Policy Network (RFPN)

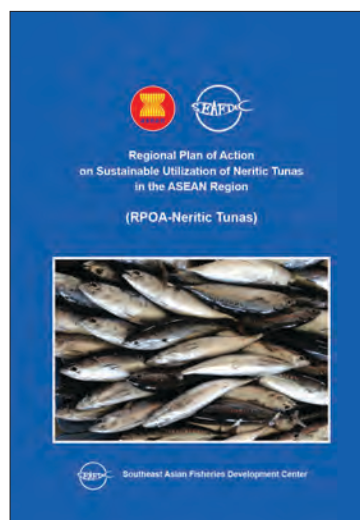
Box 3. Activities carried out under the SEAFDEC-Sweden Project to address cross-cutting issues
<ul style="list-style-type: none"> • Gender and social development
<ul style="list-style-type: none"> • Improvement of labor, working conditions, and safety-at sea
<ul style="list-style-type: none"> • Promotion of sustainable small-scale fisheries and the FAO-SSF Guidelines
<ul style="list-style-type: none"> • Supporting local partners in the implementation of activities for improved social well-being of fishers

cross-cutting issues, such as those that pertain to gender and labor aspects, local capacity-building, diversification of livelihoods, enhancing social wellbeing, and strengthening of the cooperation among the concerned countries (**Box 3**).

- **Output Objective 1: Capacity built for integration of fisheries and habitat management and adaptation to climate change**

Sustainability of transboundary species through the implementation of the Regional Plan of Action on Sustainable Utilization of Neritic Tunas in the ASEAN Region

Neritic tunas are among the economically-important species in the Southeast Asian region, and hence necessitated that their fisheries be properly managed for sustainability. The SEAFDEC-Sweden Project therefore supported the development of “Regional Plan of Action on Sustainable Utilization of Neritic Tunas in the ASEAN Region (RPOA-



The Regional Plan of Action on Sustainable Utilization of Neritic Tunas in the ASEAN Region

Neritic Tunas)” which was adopted by the SEAFDEC Council in 2015 (SEAFDEC, 2015), as well as the establishment of the “Scientific Working Group on Stock Assessment for Neritic Tunas in the Southeast Asian waters (SWG-Neritic Tunas).”

Moreover, in order to enhance the capacity of national fisheries officers on stock assessment, the Project developed the “Standard Operating Procedures (SOPs) for Data Collection and Analysis of the Neritic Tunas” and the “SOP for Collection and Preservation of DNA Tissue Samples,” and series of training sessions and workshops were organized that focused on data collection and analysis of the stock status of neritic tunas in the region. Specifically, the stock assessment of neritic tuna species, namely: longtail tuna (*Thunnus tonggol*), kawakawa (*Euthynnus affinis*), Indo-Pacific king mackerel (*Scomberomorus guttatus*) and narrow-barred Spanish mackerel (*Scomberomorus commerson*) in the Pacific and Indian Ocean sides was carried out. Genetic study was also undertaken for longtail tuna in the South China Sea, Gulf of Thailand and Andaman Sea. The results revealed the status of the species and established the scientific-based recommendations that support the management of fisheries of the species in the Pacific and Indian Ocean sides.

Management of transboundary resources/stocks through sub-regional approaches

Other transboundary aquatic species considered priority species in the Gulf of Thailand and Andaman Sea Sub-regions (involving Cambodia, Indonesia, Malaysia, Myanmar, Thailand, and Viet Nam) were also given focus under the SEAFDEC-Sweden Project. These species included the Indo-Pacific mackerels, anchovies, neritic tunas, and blue swimming crabs. Specifically, the “Standard Operating Procedures (SOPs)” was developed for data collection of transboundary species, e.g. for the Indo-Pacific mackerels, and based on such data collection, coupled with DNA collection and analysis, better understanding of the stock status was attained in Cambodia, Viet Nam, Thailand, and Malaysia



which revealed the mixed stock structure of the Indo-Pacific mackerel in the Gulf of Thailand sub-region. This led to the development of the “Regional Action Plan for Management of Transboundary Species: Indo-Pacific Mackerel in the Gulf of Thailand Sub-region,” which could serve as basis for countries to continue the study on the species and collaboration in the future (SEAFDEC, 2019 in press). Meanwhile, based on the available data of the priority species in the Andaman Sea Sub-region, digital maps indicating the spawning grounds, spawning seasons, biological characteristics, habitats and migration patterns, as well as existing fishing regulations on the priority species, *i.e.* anchovies, mackerels and neritic tunas, were established.

Improving awareness and enhancing capacity on Ecosystem Approach to Fisheries Management

The SEAFDEC-Sweden Project enhanced the capacity and knowledge of national fisheries officers by supporting the conduct of a number of training courses that aim to promote the Ecosystem Approach to Fisheries Management (EAFM), especially in Cambodia, Lao PDR, Myanmar, and Thailand. The training sessions were meant to provide additional knowledge and improve the understanding of the

concept of EAFM, and strengthen the capacity of concerned stakeholders for local management of habitats and fisheries. Events were also organized with local partners to promote habitat restoration and fishery resources enhancement to increase their awareness and appreciation of the importance of sustainable management practices and judicious utilization of fishery resources that ensure the security and sustainability of their livelihoods. There had been considerable increase in the participation of women in the discussions on fisheries management issues, and better cooperation with and among public authorities.



Development of EAFM plan

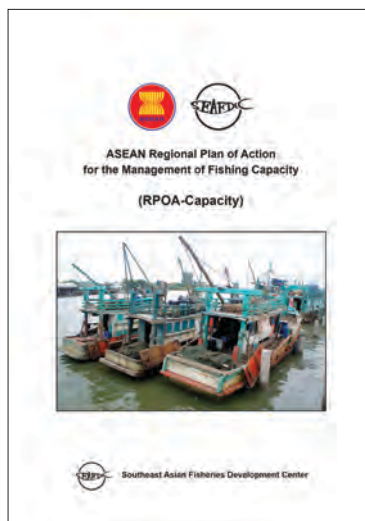


Field work for data collection

- **Output Objective 2: Capacity built and system improved for the management of fishing capacity (monitoring, record and control)**

Combating IUU fishing and management of fishing capacity

There are several challenges that confront Southeast Asian fisheries, which include among others, the need for effective monitoring and control of the fishing efforts, legality of the status of fishing operations, and proper landing and recording of fish and fishery products for the purpose of traceability throughout the supply chain. These issues had been addressed by the SEAFDEC-Sweden Project by closely linking to the efforts exerted by the AMSs, SEAFDEC, and regional and international partners, especially with regards to combating IUU fishing in the waters of Southeast Asia. Specifically, the support of the Project focused on the implementation of activities in the AMSs for improved fisheries management by providing the platform for sub-regional and bilateral discussions towards developing and agreeing on the solutions for overcapacity and IUU fishing.

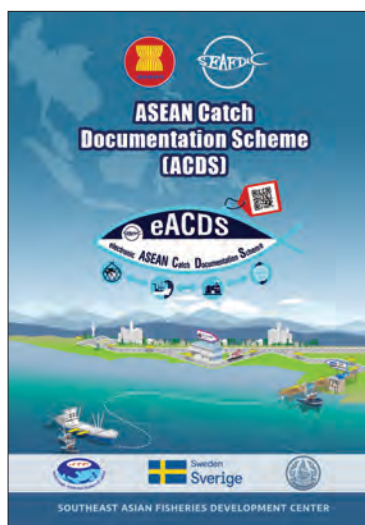


The Regional Plan of Action on Management of Fishing Capacity (RPOA-Capacity)

This led to the development and promotion of the “Regional Plan of Action on Management of Fishing Capacity (RPOA-Capacity),” which was endorsed by the SEAFDEC Council in April 2016, and subsequently by the ASEAN in June 2016 (SEAFDEC, 2017). Moreover, the concerned countries also updated their respective fisheries regulations and frameworks to cope up with the recent developments in the sustainable management of the fishery resources.

Monitoring of fishing efforts through enhanced traceability of fish and fishery products

Upon the development of the ASEAN Catch Documentation Scheme (ACDS) by SEAFDEC that was aimed at enhancing the traceability of fish and fishery products in the Southeast Asian region, the Project supported the pilot-testing of such traceability scheme in the region, and also the development of the electronic system of the ACDS or what is known as the eACDS (SEAFDEC, 2017a). Furthermore, the Project also supported the implementation of the Agreement on Port State



A brochure introducing ASEAN Catch Documentation Scheme (ACDS)

Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (PSMA) with a view to prevent the entry of IUU fishing products into the region's supply chain.

Supporting the establishment of Monitoring, Control and Surveillance Networks

The establishment of the Monitoring, Control and Surveillance (MCS) Networks had been considered as one of the means of improving the transboundary management of fisheries, controlling the fishing efforts, and strengthening surveillance systems of the concerned countries. At the outset, the countries came up with the list of information that should be shared and coordinated for enhancing the future cooperation on MCS components of the respective sub-regions, as well as the working mechanisms and the ambitions for future coordination. In addition, the participating countries agreed on establishment of single point of contact (SPOC) for GOT countries by using the same RPOA-IUU focal point network.

- **Output Objective 3: Capacity built and policy development process improved and support drafting and implementation of regional and sub-regional agreements**

Strengthening the sub-regional cooperation in target sub-regions

The SEAFDEC-Sweden Project sustained the momentum of fostering sub-regional cooperation that was initiated during the implementation of the SEAFDEC-Sida Project in the early 2000s. This involved the conduct of series of meetings serving as platforms for discussion among countries in the Gulf of Thailand, Andaman Sea, and Lower Mekong River Basin, as well as bilateral dialogues among countries in these sub-regions. Strengthening of such cooperation led to subsequent signing of Memorandums of Understanding between the countries, *i.e.* for Thailand-Cambodia, Thailand-Lao PDR, and Thailand-Myanmar. While re-affirming the importance of Gulf of Thailand Sub-regional platform, the concerned stakeholders expressed the willingness to continue this mechanism in the sub-region beyond the completion of SEAFDEC-Sweden Project. Meanwhile, in order to sustain the initiatives in strengthening the cooperation established in the Andamn Sea Sub-region, the information and key achievements derived from the Project was shared with the FAO to serve as inputs in formulation of the project “Sustainable management of fisheries, marine living resources and their habitats in the Bay of Bengal region for the benefit of coastal states and communities” to commence by the end of 2020 with FAO/GEF as prospective funding agency.

Coordination with other organizations and projects

The SEAFDEC-Sweden Project supported the joint activities and enhanced the coordination with the ASEAN and several regional and international organizations and other projects with the aim of ensuring the long-term sustainability of marine and inland aquatic resources. Regional cooperation among the AMSS, *e.g.* through joint regional, sub-regional and bilateral approaches, is also crucial in building-up and promoting their common understanding to secure sustainability bearing in mind the “transboundary” nature of several aquatic resources including mobility of fishers that utilize such resources.

The project coordinated closely with several organizations and projects, particularly the FAO Headquarters in Rome and Regional Office in Bangkok, the Asia-Pacific Fisheries Commission (APFIC); the Secretariat of Regional Plan of Action to Promote Responsible Fishing Practices including Combating IUU Fishing (RPOA-IUU). The Project also shared information on its activities with several organizations and projects such as USAID, IUCN, International Labour Organization (ILO), SEAFDEC/UNEP/GEF/Fisheries *Refugia* Project, SEAFDEC/Japanese Trust Fund (JTF).

Furthermore, throughout the course of its implementation, the SEAFDEC-Sweden Project collaborated with a number of local partners, namely: Learning Institute (Cambodia), CORIN-Asia Cambodia, and Sustainable Development Foundation (SDF) Thailand, in the implementation of activities at the local community levels. Results of the activities of such collaboration had facilitated the sharing of experiences and lessons learned from local implementation with other relevant organizations/sector and youth, while awareness on coastal community's livelihood and fisheries and coastal ecosystem were also enhanced. Improved relationship among relevant government agencies, organizations, academic institutes and local communities, including among those in Thailand and Cambodia, were also fostered.

Enhancing Coordination with countries through the Regional Fisheries Policy Network (RFPN)

The SEAFDEC-Sweden Project had been supporting certain numbers of officers from national fisheries agencies of the Member Countries, namely: Indonesia, Malaysia, Myanmar, Thailand, and the Philippines (JTF supported Cambodia, Lao PDR, and Viet Nam), to be stationed at the SEAFDEC Secretariat for one-year period. The RFPN members had been playing active roles in enhancing coordination and communication between SEAFDEC and their respective countries, while also being given the opportunity to provide technical contributions in various events organized by SEAFDEC.

- **Addressing Cross-cutting Issues in Fisheries**

Gender and Social Development

The SEAFDEC-Sweden Project worked with SEAFDEC on the integration of gender in the project implementation and in enhancing the cooperation with other partners toward the promotion of gender equality in the fisheries sector. More specifically, the Project supported the development of the “Practical Guide for Gender Analysis in Small-Scale Fisheries and Aquaculture in Southeast Asia” using as framework, the key components of the “FAO Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (SSF Guidelines).”

The Practical Guide includes the available tools and procedures that could be used for gender analysis, together with guide questions, examples of gender-sensitive indicators, and methods for data analysis. It would be used as a tool to support the AMSs in integrating gender and social well-being in the entire cycle of their respective programs and projects to obtain sustainable fishery resources and eradicate poverty in small-scale fishing communities. The Project also supported the development of “SEAFDEC Gender Strategy” that strives to mainstream and integrate gender perspectives into the SEAFDEC organization, and in its programs, projects, and activities. The Strategy was approved by the SEAFDEC Council in 2019 (SEAFDEC, 2019a).

Improvement of labor, working conditions, and safety-at-sea

Improved labor and working conditions in fisheries, as well as safety at sea are among the most important cross-cutting elements that would facilitate the promotion of sustainable fisheries. For these aspects, the SEAFDEC-Sweden Project



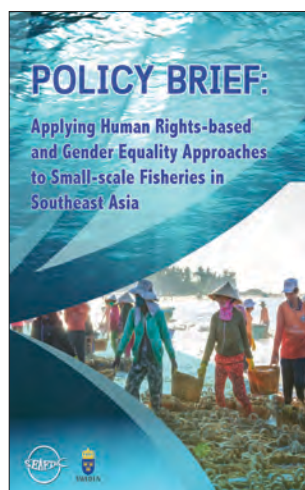
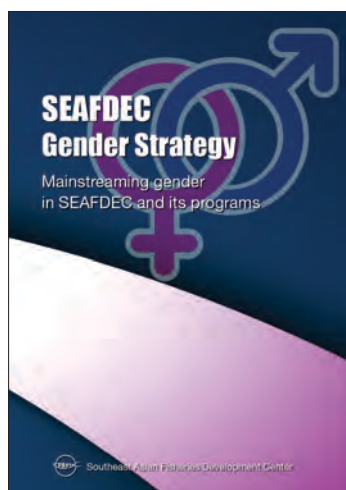
collaborated and sustained dialogues with the International Labour Organization (ILO) and the Food and Agriculture Organization (FAO) to address the issues against the backdrop of the conditions in the AMSs.

Promotion of sustainable small-scale fisheries and the FAO-SSF Guidelines

After the adoption of the “FAO Voluntary Guidelines for Securing Sustainable Small-scale Fisheries in the Context of Food Security and Poverty Eradication” (SSF Guidelines), efforts were made by countries, regional organizations, and the civil society to support the steps in the implementation of the SSF Guidelines. In this connection, the SEAFDEC-Sweden Project collaborated with FAO and other partners in promoting the process of applying the regional approach, and came up with the “Policy Brief” that would serve as reference to improve understanding and awareness of the principles contained in the SSF Guidelines. The Policy Brief includes the benefits and implications of the SSF Guidelines to the region, taking into consideration the “human-rights based approach” and “gender equality and equity” in small-scale fisheries (SEAFDEC, 2018).

Supporting local partners in the implementation of activities for improved social well-being of fishers

The Project supported the rural and coastal communities in strengthening their ability to adapt to the effects of climate change, manage natural resources, conserve or restore critical habitats, develop and manage diversified livelihood options and alternative income-earning opportunities, and promote gender equity and equality. In so-doing, the Project engaged local partners that have considerable experience in rural development and strong presence in the Project sites. These partners include: CORIN-Asia-Cambodia, Learning Institute



SEAFDEC publications on gender: the SEAFDEC Gender Strategy (left) and the Policy Brief: Applying Human Rights-based and Gender Equality Approaches to Small-scale Fisheries in Southeast Asia (right)

(Cambodia), Sustainable Development Foundation (Thailand), and CORIN-Asia Myanmar. During the implementation of the collaborative activities, the role of women and youth had been enhanced as they had been provided with the opportunities to assume leadership or for more meaningful involvement in the activities. The Project had therefore fostered multi-stakeholder collaboration among local stakeholders, including the fisher communities, local administration, and provincial level government agencies.

Conclusion and Recommendations

Towards the completion of the SEAFDEC-Sweden Project, SEAFDEC convened the two-day “End of Project Meeting of the SEAFDEC-Sweden Project: Fisheries and Habitat Management, Climate Change and Social Well-being in Southeast Asia (2013-2019)” on 30-31 October 2019



Proceedings of the End of Project Meeting

Box 4. Key Messages for sustaining the initiatives of the SEAFDEC-Sweden Project

On Transboundary Species

- Although several species are recognized as transboundary and shared among countries in the region, each country has sovereign rights only in its own waters, but not in other countries' waters, making it difficult to undertake regional activities on and regional management of the transboundary species that has implications to other countries' EEZ. Intervention from regional bodies/organizations would be necessary in this aspect of work.
- Activities at the regional and sub-regional levels had been implemented such as those on several transboundary species, *e.g.* neritic tuna species, Indo-Pacific mackerels, anchovies, and other small pelagic species, to improve understanding of the species and to come up with science-based management of fisheries but there were obstacles that hindered data collection and stock assessment. These include:
 - o Some countries still have insufficient capacity as well as system of collecting data that could support the conduct of stock assessment
 - o CPUE data among countries are not harmonized, considering that CPUE should be standardized for purposes of stock assessment
 - o Limited expertise and methodologies for stock assessment of transboundary species using the data available in some countries
- Neritic tunas: data available in some countries were used for stock assessment and risk assessment of some neritic tuna species, such as longtail tuna, kawakawa, Indo-Pacific king mackerel, and narrow-barred Spanish mackerel in the Pacific and Indian Oceans, and came up with scientific-based recommendations that support the management of fisheries of the species in the respective areas. Results of these technical works have been submitted to the ASEAN for consideration in the development of future management plans of these species.
- Indo-Pacific mackerel: Results of the DNA study proved that Indo-Pacific mackerel is a transboundary resource in the Gulf of Thailand and requires regional cooperation for management. However, since the study could not come up with conclusive results on the status and migration patterns of the species, it was suggested that other technologies should be used, *e.g.* microsatellite. Nevertheless, a Regional Action Plan is being developed suggesting the need for regional collaboration to support better understanding of the species in the future, specifically to:
 - o Improve the capacity of the countries in data collection and analysis of the stocks of transboundary species, by mobilizing the available expertise from other national institutions in the respective countries
 - o Continue regional cooperation for data collection and stock assessment of transboundary species in collaboration with regional organizations, including in the implementation of the RPOA-Neritic Tunas and its SWG, the Regional Action Plan for Indo-Pacific Mackerel in the Gulf of Thailand
 - o Transform the scientific findings into materials that could be easily understood by policy makers and fisheries managers, as well as fishers
 - o Seek support from organizations, *e.g.* from SEAFDEC, as well as from potential donor agencies, *e.g.* FAO, USAID, JTF, to continue the activities

On EAFM

- Promotion of Ecosystem Approach to Fisheries Management (EAFM) has been facilitated in the ASEAN Member States (AMSs), starting with customizing the training materials on EAFM, building the capacity for fisheries officers of the AMSs on the EAFM concept, and training of trainers so that officers of the AMSs could transfer the concept to relevant stakeholders in the countries. Subsequently after a series of training activities, SEAFDEC started applying the EAFM concept in learning sites in Myanmar, Cambodia, Lao PDR, and Thailand.
- To sustain the efforts, it is necessary for the AMSs to build up their own capacity and allocate resources for the promotion of EAFM concept, and application of the concept in real situation. However, support from external agencies particularly SEAFDEC and other donors is still necessary to expedite and enhance the efficiency of the activities, *e.g.* starting from small learning sites and subsequently expanding these to larger levels.

On Sub-regional Cooperation for Combating IUU Fishing

- The most important prerequisites for combating IUU fishing include consistent and strong political will, and amendment of the country's legal frameworks to comply with the requirements of relevant international instruments. In preventing the entry of IUU fish into the supply chain, there is a need to combine the measures that address different points of the supply chain where IUU products can enter. However, combating IUU fishing should also take into consideration the circumstances of the countries, *e.g.* the need for securing rights of small-scale fishers as well as the livelihood/welfare of the communities.
- Comparative studies on laws and regulations were conducted by SEAFDEC for some neighboring areas of some countries in the region. Results of such studies have been beneficial for these countries in-terms of enabling fisheries officers at the local level to obtain better understanding of other country's laws and regulations; helping fishers to avoid violating other countries' regulations; serving as reference for collaborative projects in transboundary areas; and identifying the gaps and what needs to be done to ratify relevant international instruments.
- Amendment of the countries' fisheries laws and regulations could be one of the important indicators that demonstrate their alignment with emerging initiatives and international requirements, *e.g.* the EAFM and Co-management concepts, Port State Measures Agreement (PSMA), International Labour Organization (ILO) Convention, etc. However, for some countries high-level policy decisions are also important, *e.g.* for combating IUU fishing, control of fishing efforts, moratorium on destructive fishing gears, transshipment at sea or in other country's port, etc. without necessarily amending their existing laws and regulations.
- To strengthen Monitoring, Control and Surveillance (MCS), establishment of MCS networks has been initiated with the support of the SEAFDEC-Sweden Project. Through this initiative, mechanisms for collaboration and information sharing among concerned agencies within and among the countries in the region have been initiated. Nevertheless, it is necessary that regional MCS mechanism should also be promoted by relevant regional organizations, particularly for the different sub-regional areas of the region.
- The Port State Measures (PSM) is considered as very effective tool for combating IUU fishing by preventing the entry of IUU fish, particularly from foreign vessels into the country. However, there is still a need to ensure that the country's legal frameworks are compliant with the PSM requirements, including capacity building of relevant authorities in the implementation of the PSM.
- The Regional Plan of Action for Management of Fishing Capacity was developed with support from the SEAFDEC Sweden Project upon the request of Malaysia during the ASWGF Meeting. While some countries could already implement the management of fishing capacity, but to support the Southeast Asian region in the implementation of the RPOA-Capacity as a whole, there is a need for a regional platform for the countries to enhance their understanding and improve their existing laws and regulations through sharing of experiences among countries.
- The ASEAN Catch Documentation Scheme (ACDS) is also one of the most effective tools for combating IUU fishing. Implementation of ACDS not only enables the traceability of fish and fishery products, but also enhances international trade of fish and fishery products. Nevertheless, successful implementation of the ACDS is long process as it also requires several management systems to be put in place in the country, *e.g.* port-in port-out, catch report at sea, report at landing sites, report by processors. In order to overcome some difficulties faced in ACDS operations, *e.g.* limited wifi signal at sea, SEAFDEC would continue to promote the use of off-line technologies. Furthermore, besides implementing the ACDS in more countries in the region, the expansion of ACDS to also cover traceability of products from aquaculture and hatcheries intended for export should also be considered

In addressing cross-cutting issues at the community level

- In securing the sustainable development of the fisheries sector, there are several cross-cutting issues that need to be addressed, such as the need to enhance the capability of stakeholders to take up livelihood diversification options and to adapt to the effects of climate change for poverty alleviation. In order to address these issues, support was provided to local partners, namely: Learning Institute, CORIN-Asia Cambodia, Sustainable Development Foundation, and Prince of Songkla University (PSU), to implement the relevant activities at the local community level.
- Problems encountered during the implementation of the Project at the community level:
 - o Deterioration of habitats due to habitat destruction and inadequate waste management
 - o Declining fishery resources due to overfishing and use of destructive fishing gears
 - o Inadequate knowledge and skills in mitigating the impacts of climate change, climate variability, natural hazards
 - o Insufficient information on traditional fisheries in the governmental information system
 - o Limited roles of women in fishing communities
- Interventions for the local communities:
 - o Governance: strengthening of alliance among local government agencies toward integrated coastal zone management (ICZM)
 - o Habitat protection and resources restoration: promotion of effective household garbage management; restoration of coastal habitats such as seagrass beds, mangrove forest, artificial reefs; promotion of crab bank; habitat and resource conservation campaign
 - o Introduction of livelihood diversification opportunities to generate income and reduce illegal fishing activities: marine cage culture of aquatic species, eco-tourism, fish processing, and other options in the non-fishery sectors
 - o Establishment of marketing groups and micro-credit schemes that would provide loans within the community
 - o Adaptation and mitigation of the impacts of climate change, climate variability and natural hazards, including the promotion of alternative livelihoods that take advantage of changes in climate/season, dissemination of information on the weather conditions in advance (*i.e.*, an early warning system)
 - o Development of fishers' database with the participation of all groups of stakeholders
 - o Strengthening community capacity to develop projects and undertake activities in collaboration with government agencies, to ensure the sustainability of operations after the completion of projects with external support
- Through the activities of SEAFDEC-Sweden Project, tangible results had been generated that improve the livelihoods of the communities. However, certain activities towards long-term sustainable management of the fishery resources need to be continued after the completion of the Project in December 2019, particularly on the application of EAFM, co-management and gender integration. In this connection, technical support from SEAFDEC and other organizations would still be necessary.

Box 4. Key Messages for sustaining the initiatives of the SEAFDEC-Sweden Project (Cont'd)

On Gender Integration

- Several activities were undertaken by SEAFDEC in collaboration with other organizations and local institutions, including research on gender mainstreaming in fisheries, and development of methodologies and tools for gender analysis in small-scale fisheries and aquaculture in the region. Through such activities, SEAFDEC has established close partnerships with other organizations to work on the gender dimension, and developed the SEAFDEC Gender Strategy.
- In further strengthening gender integration in fisheries, activities should be undertaken (also with support from SEAFDEC and other organizations) towards:
 - o Building the capacity of local officers on gender concept, gender mainstreaming in projects dealing with communities, and gender analysis;
 - o Establishing a pool of gender expertise in the region;
 - o Incorporating gender analysis at the community level, e.g. collection and analysis of data on fisheries, socio-economics, livelihood, market, etc.;
 - o Promoting the involvement of women in the development of fisheries/resources management plans;
 - o Strengthening the roles and responsibilities of women in household and community activities as well as in the society;
 - o Enhancing the opportunities of women to access and utilize assets and resources, including education, training, technical advice on entrepreneurship, and other opportunities;
 - o Ensuring that women in the fisheries sector receive recognition and benefits on their own rights; and
 - o Collecting and compiling sex-disaggregated statistics on fisheries.

On the provision of the sub-regional platforms

- The sub-regional approach that builds upon the national systems/networks of the participating countries, while cooperation among the countries was established at the sub-regional level. Such approach has led to benefits gained by the countries in addressing priority issues under particular sub-regional focuses, enhancing the effectiveness in mobilizing resources to address such priorities, while also serving as basis for the establishment of long-term arrangements between and among neighboring countries in the sub-region.
- Focusing on the Gulf of Thailand, Andaman Sea, Sulu-Sulawesi Seas and Mekong Sub-region, the priority issues that has been addressed through sub-regional cooperation focused on:
 - o Combating IUU fishing, e.g. sharing/exchanging of information on laws, regulations and practices, and enhancing coordination/networking of initiatives among countries including MCS network
 - o Management of transboundary species, e.g. on data collection, sharing and analysis, and development of management measures at sub-regional level
- Moving forward to the implementation of the sub-regional approach in the future, the following aspects should be considered:
 - o Support for the formulation and implementation of projects using sub-regional approach, such as the BOBLME and Gulf of Thailand (GOTFish) in collaboration with relevant organizations
 - o Formalization of mechanisms for the different sub-regions in the areas of planning, implementation, and in monitoring/evaluation of activities addressing their priority issues
 - o Support for the development and implementation of action plans among countries to address issues that need to be addressed at sub-regional level, e.g. combating IUU fishing, management of transboundary species, habitat and species conservation
 - o Capacity building for countries to support activities under the sub-regional platform

in Bangkok, Thailand. The Meeting participants who comprised the stakeholders involved through the project implementation shared their experiences and lessons learned on: 1) transboundary fishery resources; 2) regional and sub-regional cooperation for the management of fishing capacity and combating IUU fishing; 3) livelihoods diversification and adaptation to climate change for poverty alleviation; 4) gender integration in fisheries; and 5) sub-regional platforms.

The shared experiences, best practices, lessons learned from the implementation of the Project, and the recommendations from the participants were distilled into a set of Key Messages (**Box 4**) that would serve as guidelines to SEAFDEC, ASEAN, Governments of the AMSs and the Partner organizations for building on the results and sustaining the initiatives of the Project.

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Enhancing the Management of the Indo-Pacific Mackerel Resources in the Gulf of Thailand: a synthesis

Kay Khine Tint, Kamsan Ngin, Agus Sapari, Khambor Souliphone, Sumolmal Suwannapoom, Jennifer G. Viron, and Vu Thi Phuong Thanh

In Southeast Asia, the Gulf of Thailand has one of the highest potentials in terms of pelagic fishery resources, due to its shallow topographic bottom features forming the Gulf into a large basin, the seasonal change in wind and current, and the several rivers that discharge water and nutrients into it. With a surface area of 320,000 km² (123,553 mi²), the Gulf of Thailand (GoT) is bordered by four countries, namely: Cambodia, Malaysia, Thailand, and Viet Nam. GoT is well recognized for its important habitats and abundance of marine aquatic resources, with fisheries sector that provides significant livelihoods, food security and nutrition to the people of the GoT countries. At present however, the fishery resources in GoT is declining due to fishing pressure, and the rampant practice of illegal, unreported and unregulated (IUU) fishing. In order to address such concerns, the bordering countries of GoT exerted efforts to manage the resources of the Gulf that include the promotion of collaborative fisheries management for commercially-important transboundary species such as anchovy, Indo-Pacific mackerel and blue swimming crab. This article focuses on the management of the Indo-Pacific mackerel (*Rastrelliger brachysoma*) resources in the Gulf of Thailand.

Series of consultations among the countries bordering the Gulf of Thailand (Figure 1) had been organized by SEAFDEC with support from the SEAFDEC-Sweden Project. In one of such consultations, it was agreed that the status of the fishery resources in the GoT should be assessed, with initial focus on three priority economically-important species, namely: anchovies, Indo-Pacific mackerel, and blue swimming crab or what is known as the AIB species (SEAFDEC, 2017a; SEAFDEC, 2017b). The SEAFDEC-Sweden Project therefore coordinated with the GoT countries, to



Figure 1. Gulf of Thailand bordered by Cambodia, Malaysia, Thailand, and Viet Nam

facilitate the conduct of human resource development activities to enhance the technical expertise of the countries with respect to the management of the AIB species. As a result, the GoT countries initiated the sustainable management activities for the Indo-Pacific mackerel as it is one of the most economically-important transboundary species in the Gulf of Thailand.

Indo-Pacific Mackerel Resources in the Gulf of Thailand

Indo-Pacific mackerel (*Rastrelliger brachysoma*), also known as short mackerel (Figure 2), is a species of mackerel in the family *Scombridae* having a typical appearance of a medium-sized fish and silver in color. The head is equal to or less than the body depth. Very long gill rakes could be seen when the mouth opens, and the snout is pointed. There are five dorsal and anal filets present, where the pectoral and pelvic fins are dusky, while the other fins are yellowish in color. The Indo-Pacific mackerel is distributed along the coastal areas, less than 50 m in depth. Even though pelagic in nature, the Indo-Pacific mackerel prefers to feed in estuarine habitats, and is a plankton feeder.

As noted during the series of consultations among the GoT countries (SEAFDEC, 2017b), the spawning season of the Indo-Pacific mackerel is all year round, and the spawning grounds are in the middle part of the GoT (Figure 3). The gravid fish moves from the inner Gulf to spawn to the Middle Gulf. The fertilized eggs float in the area of 20-80 meter depths and then the juveniles move into the inner Gulf. Fishing peak is usually highest in January-March and June-August.

The Indo-Pacific mackerel is among the major economically-important species in the Southeast Asian region, especially for Cambodia, Indonesia, Malaysia, Philippines, and Thailand. In the SEAFDEC Statistical Bulletin of Southeast Asia (SEAFDEC, 2014; SEAFDEC, 2015; SEAFDEC, 2017e; SEAFDEC, 2017f; SEAFDEC, 2018a) however, the data from Cambodia and Malaysia had not been included in the production of short mackerels as these had been reported under *Rastrelliger* spp. Nonetheless, the compiled information indicated that the total catch of short mackerels in the region contributed an average of



Figure 2. Indo-Pacific mackerel (*Rastrelliger brachysoma*)

about 2.5 % to the total marine catch of Southeast Asia during the past five years (*i.e.* 2.9 %, 2.6 %, 2.7 %, 2.3 %, and 2.1 %, in 2012, 2013, 2014, 2015, 2016, respectively), a trend which also conforms to the decreasing total production of all mackerels in the region (**Table 1**).

Based on the statistics shown in **Table 1**, production of the Indo-Pacific mackerel in GoT (reflecting data from Indonesia and Thailand only) had reduced during the period from 2012 to 2013, increased in 2014 but declined sharply from 2015 to 2016, in spite of the enforcement of seasonal fishing closure measures by most of the GoT countries. Thus, it could then be roughly assumed that the mackerel resource must have already reached its MSY level since 2010-2011 even if the catch increased in 2014, considering that the catch exhibited another decreasing trend since then. It should be noted however, that this trend does not include the status of the resource in Malaysia and Cambodia, where the catch of Indo-Pacific mackerel is lumped together with that of the other mackerels.



Figure 3. Spawning areas of the Indo-Pacific mackerel (*Rastrelliger brachysoma*) in the Gulf of Thailand

Source: Department of Fisheries Thailand

The review of the status of the Indo-Pacific mackerel resource in the Gulf of Thailand (SEAFDEC, 2017b) indicated that in Cambodia, catch of Indo-Pacific mackerel had been reported in Sihanouk Province with two high catch peaks, *i.e.* the first is in January and February; and second peak in July, September, and October, accounting for 86 % of the country's total pelagic catch in 2003-2004. In Kampot Province, where catch of Indo-Pacific mackerel is also reported, the high peak is in May, June, July and September, contributing about 63 % to the total pelagic catch as of 2004.

In Thailand, the fishing ground of Indo-Pacific mackerel is along the west coast of upper part of the Gulf of Thailand. In Malaysia, the catch of the Indo-Pacific mackerel in Tok Bali and Kuantan in 2005 accounted for 3 % and 1 %, respectively, to the total fisheries production of these States. In Viet Nam in 2003, the catch of Indo-Pacific mackerel from Ben Tre Province contributed 4.4 % to the total fisheries production of the Province.

Although Indo-Pacific mackerel is one of the major commercially-important species in the GoT, its production has been reported to be declining because of overfishing by the mackerel gill net, encircling gill net, purse seine, and pair trawl. The high fishing pressure had prompted the countries bordering the GoT to adopt conservation measures for the Indo-Pacific mackerel (*Rastrelliger brachysoma*), which is a very popular pelagic species in these countries.

Management of the Indo-Pacific Resources in the Gulf of Thailand Sub-region

In an effort to address the aforementioned concerns, the SEAFDEC-Sweden Project supported the GoT countries, *i.e.* Cambodia, Malaysia, Thailand, and Viet Nam, to embark on series of consultations to discuss the management of transboundary species towards the sustainability of the fishery resources. During the Fifth Meeting of Gulf of Thailand Sub-region in 2015 (SEAFDEC, 2017a), the GoT countries agreed to focus on target species, namely: anchovies, Indo-Pacific mackerel and blue swimming crab (also known as AIB species) and to

Table 1. Total production of short mackerel in Southeast Asia (in metric tons)

	2012	2013	2014	2015	2016
Indonesia (57) ^a	96,981	96,181	98,398	99,370	98,193
Indonesia (71) ^b	169,377	143,035	171,013	172,170	184,913
Philippines (71)	46,572	43,180	39,602	38,881	38,339
Thailand (57) ^c	14,196	20,593	25,507	16,851	4,463
Thailand (71) ^c	125,619	115,471	116,936	53,452	26,657
Production of short mackerel of Southeast Asia	452,745	418,460	451,456	380,724	352,565
Production of short mackerel of GoT	139,815	135,280	142,443	70,303	31,120
Production of all mackerels of Southeast Asia	1,018,026	1,080,358	1,063,810	1,034,974	874,770
Total: marine capture fisheries production of Southeast Asia	15,478,831	16,137,163	16,583,626	16,762,392	17,027,312

^a Fishing Area 57 includes: marine fishing areas of Myanmar, Thailand (Indian Ocean), Malaysia (West Coast of Peninsular Malaysia), Indonesia (Malacca Strait), Indonesia (West Sumatra and South Java), Indonesia (Bali-Nusa Tenggara)

^b Fishing Area 71 includes: Gulf of Thailand, marine fishing areas of Cambodia, Southwest and Southeast Viet Nam, East Coast of Peninsular Malaysia, Sarawak, Sabah, Singapore, Brunei Darussalam, Philippines (Luzon, Visayas, Mindanao), Indonesia (East Sumatra, North Java, Bali-Nusa Tenggara, South-West Kalimantan, South Sulawesi, North Sulawesi, Maluku-Papua)

^c Reported by Thailand as *Rastrelliger spp.* although classified as *Rastrelliger brachysoma* (Indo-Pacific mackerel)
Source: SEAFDEC (2014; 2015; 2017e; 2017f; 2018a)

immediately start working on the formulation of management actions for the Indo-Pacific mackerel including improvement of data collection to support long-term fisheries management. This led to the promotion of management measures for the Indo-Pacific mackerel in the GoT countries which comprises the implementation of closed season and closed area from 1 June to 31 July of every year, and the enforcement of regulations prohibiting the use of some commercial gears during the closed season and protecting the nursery grounds of the Indo-Pacific mackerel.

Moreover, during the subsequent Experts Group Meeting for Stock Status and Geographical Distribution of AIB Species in the GoT in 2016 (SEAFDEC, 2017b), it was agreed that study on the Indo-Pacific mackerel stock in the GoT should be pursued. This led to the recommendation that DNA studies on the stock structure of the Indo-Pacific mackerel in the GoT sub-region should be carried out, specifically to determine the stock population of Indo-Pacific mackerel in the GoT and identify the major populations that contribute to the total production of Indo-Pacific mackerel in the GoT Sub-region (SEAFDEC, 2017c).

DNA Studies on Stock Structure of Indo-Pacific Mackerel in the Gulf of Thailand

The Technical Meeting on Planning for Development of Stock Study for Anchovies, Indo-Pacific Mackerel and Blue Swimming Crab (AIB Species) in the Gulf of Thailand on 7-8 February 2017 in Bangkok (SEAFDEC, 2017c), identified the priority activities and information needs for AIB species management, and discussed the indications that there could be three or possibly four stocks of Indo-Pacific mackerel in the Gulf of Thailand. During the subsequent consultations among GoT countries in 2018, it was agreed that DNA collection and analysis for Indo-Pacific mackerel in the GoT should be pursued to better understand the stock status in Cambodia, Viet Nam, Thailand, and Malaysia.

In 2018, tissue samples of the Indo-Pacific mackerel were collected from four main spawning grounds in Thailand (Trat, Samut Songkhram, Prachuap Khiri Khan, Surat Thani), Pattani (Thailand), Cambodia, Malaysia, and Viet Nam. The results of the DNA analysis which were presented during the Gulf of Thailand Technical Meeting on Management of Transboundary Species: Indo-Pacific Mackerel on 19-20 December 2018 in Bangkok, Thailand, could serve as inputs for the proposed development of the draft regional action plan for the sustainable management of the Indo-Pacific mackerel in the Gulf of Thailand Sub-region. The Technical Meeting (SEAFDEC, 2018b) also came up with the recommendations and follow-up actions and needs towards the development of the sub-regional transboundary species management plan for Indo-Pacific mackerel (**Box 1**).

Results of DNA studies and data collection

Based on 436 samples collected monthly from Thailand, Cambodia, Malaysia, and Viet Nam, results of the analysis indicated that there could be different populations of Indo-Pacific mackerel in the Gulf of Thailand (SEAFDEC, 2018b, Kongseng S., *et al*, 2020). Specifically, the populations in Thailand were

found to be genetically different from each other at moderate levels, while the populations in Cambodia, Malaysia, Viet Nam, and Pattani (Thailand) showed to be genetically different from each other at low levels. Moreover, while the populations in Cambodia and Viet Nam could not be clearly separated genetically, but in view of the close geographical distance between the sampling localities, the results revealed that the mackerel population from Malaysia was genetically close to the mackerel from Pattani (Thailand). The aforementioned findings led to the recommendation for the conduct of genetic Mixed-Stock Analysis (MSA) of the Indo-Pacific mackerel in the Gulf of Thailand which could build upon the results of the Genetic Mixed-stock Analysis for Short Mackerel in the Upper Gulf of Thailand conducted from 2014-2016 (SEAFDEC, 2019c).

Considering the baseline populations of the Indo-Pacific mackerel in four major spawning grounds in the GoT (**Figure 4**), and the gene flow pattern of the Indo-Pacific mackerel in the waters of Thailand (**Figure 5**), there is the possibility that the same stock of mackerel is utilized by some countries in the GoT. This is based on results of genetic studies to determine the baseline

Box 1. Recommendations and follow-up actions and needs towards the development of the sub-regional transboundary species management plan for Indo-Pacific mackerel	
Recommendations	Follow up Actions
Mixed Stock Analysis (MSA) of Indo-Pacific mackerel populations in Cambodia, Malaysia, and Viet Nam	<ul style="list-style-type: none"> For discussion with the Fishery <i>Refugia</i> Project on the possibility of accommodating the activity in their workplan considering that the SEAFDEC-Sweden Project is already completed
Monitoring of tidal change, sea surface temperature, larval transport in the GoT	<ul style="list-style-type: none"> Consultation with GoT countries on the possibility of installing data logger in safe place of GoT countries or establish collaborative research on the aspect with the academic institutions
Simulation of chlorophyll-a, current, temperature, etc.	<ul style="list-style-type: none"> Strengthening of coordination and collaboration with GoT countries under the Fishery <i>Refugia</i> Project
Conduct of biological and physical studies in the GoT	<ul style="list-style-type: none"> Following-up progress and development with SWG physical oceanography and fish larvae expert of the JTF Project Establishing the hotspots of eggs and larvae in GoT (by referring to results of studies carried out by the M.V. SEAFDEC 2)
Continue stock assessment	<ul style="list-style-type: none"> Strengthening coordination with SWG (ASEAN-SEAFDEC) to carry out stock assessment through: conduct of population stock in the GoT; collect total landings; carry out MSA; and prioritization of the most important genetic stock
Establishment of database	<ul style="list-style-type: none"> Include all important data/information for management Establishment of Specialists Group

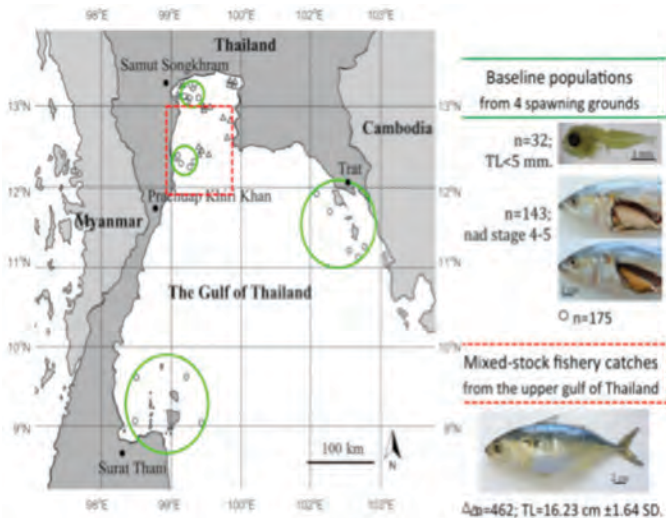


Figure 4. Baseline populations of Indo-Pacific mackerel in four major fishing grounds in the Gulf of Thailand

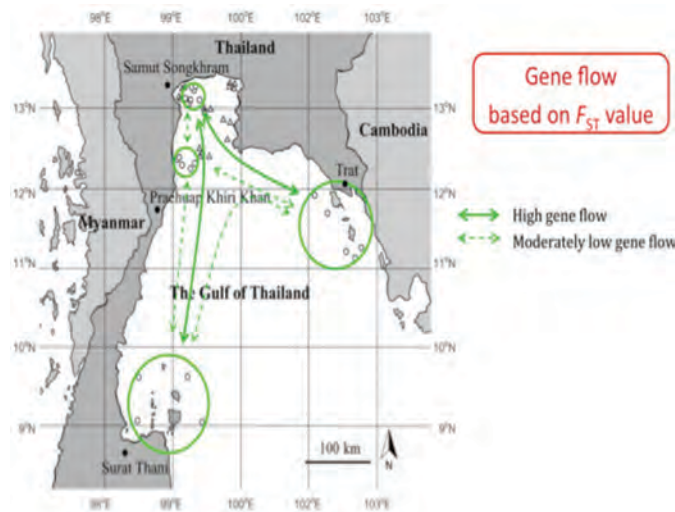


Figure 5. Gene flow of the Indo-Pacific mackerel in the Gulf of Thailand

populations, which suggested that there are possibly four (4) different populations in the GoT, namely from those from i) Trat, ii) Samut Songkhram, iii) Prachuap Khiri Khan, and iv) Surat Thani, and that the stocks between Trat and Samut Songkhram, Surat Thani and Samut Songkhram do migrate although little movement had been observed for the stocks between Trat and Prachuap Khiri Khan, and Surat Thani and Prachuap Khiri Khan.

More specifically, the genetic mixed-stock analysis for the short mackerel in the Upper Gulf of Thailand made use of samples collected from spawning grounds in Samut Songkhram, Prachuap Khiri Khan, Surat Thani, and Trat to identify the major populations contributing to the fish catch in the Upper Gulf using DNA information. Results showed that the population of short mackerel from Samut Songkhram has been the major contributor to the total catch of short mackerel in the Upper GoT. The populations from Trat and Surat comprise the second and third large contributor and also provide gene flow to the Samut Songkhram population (Figure 6). The population from Prachuap Khiri Khan has been the smallest contributor and has low gene flow to the other spawning areas.

Meanwhile, the results of the mixed-stock analysis (MSA) also showed that population of major, second and third contributors had high impact to the fishery catch in the upper GoT while the smallest contributor had low impact (Figure 6). Moreover, the nearshore waters of Prachuap Khiri Khan has been identified as the spawning ground for its local population while the offshore area is the migratory route for the populations from Samut Songkhram and SuratThani.

Many research studies had been conducted to understand the stock status, migration pattern and the spawning season of Indo-pacific mackerel resources in the Gulf of Thailand with the objective of achieving sustainability of the resources. Results of such stock studies that were presented during the 2018 Gulf of Thailand Technical Meeting (SEAFDEC, 2018b) are summarized in Box 2.

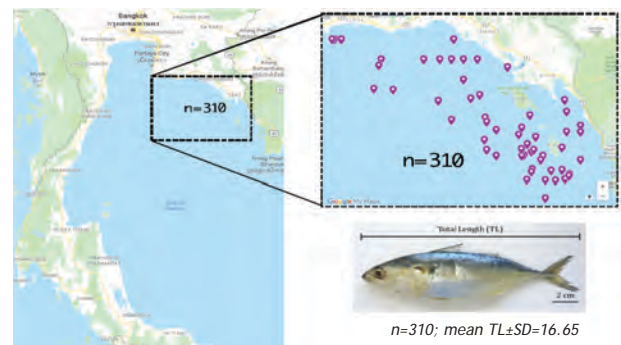


Figure 6. Mixed-stock analysis for the Indo-Pacific mackerel in the Gulf of Thailand

Way Forward

The Indo-Pacific mackerel is one of the important species in the Gulf of Thailand that should be managed for sustainable utilization. Several initiatives have already been done to realize the management of the species. In 2017, capacity building on stock assessment, species identification and genetic studies were conducted to enhance the capability of the human resources in the sub-region. SEAFDEC facilitated the compilation of the necessary information about the Indo-Pacific mackerel because of the insufficient information on its stock structure. In this regard, Malaysia and Thailand agreed to update their national initiatives on the management of transboundary/shared stocks (including Indo-Pacific mackerel). The countries also agreed to pursue exchange of data and establish MoU for the management of the mackerel resources in the Gulf of Thailand.

On the DNA analysis, Viet Nam recommended that sampling stations should cover more areas to obtain more information for all the countries involved. Cambodia, on the other hand pointed out that sampling should be done along the coastal areas of the provinces, although difficulties in implementing genetic studies maybe encountered due to the need for budget to continue the activity. In addition, it was suggested that a study on fish egg and larvae in the Gulf of Thailand should be conducted to provide a clear picture of the spawning and nursing ground of the species. In addition, it was also suggested that the results from DNA analysis

Box 2. Results of other stock studies on the Indo-Pacific mackerel presented during the 2018 Gulf of Thailand Technical Meeting

• Study on Indo-Pacific Mackerel Resource in Relation to Sea Surface Environment in the Gulf of Thailand

The status of Indo-Pacific mackerel in the GoT in relation with sea surface environment was determined by looking at the changing population of the Indo-Pacific mackerel using satellite data. This involved examining the changes in the chlorophyll-a of the water surface, plankton, water quality, distribution of fish larvae, biological and ecological data of adult fish, and economic data. Results indicated that changes of the phytoplankton affected the distribution of fish larvae as it had some impacts on the optimum condition of water current in GoT, more particularly on the temperature (Figure 7, Figure 8). However, the area for fish larvae in the GoT should be identified through further research, as the results could be used to update the closed areas which might have to be shifted based on the data on the gonad development of female mackerel.

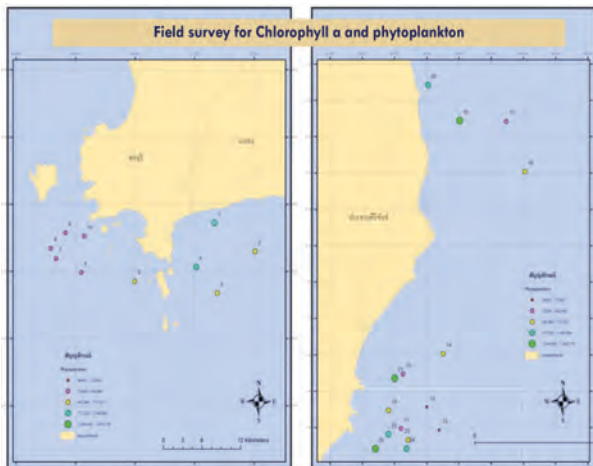


Figure 7. Sites of field surveys for chlorophyll-a and phytoplankton in the Gulf of Thailand

Source: Dr. Methee Kaewnern, Kasetsart University

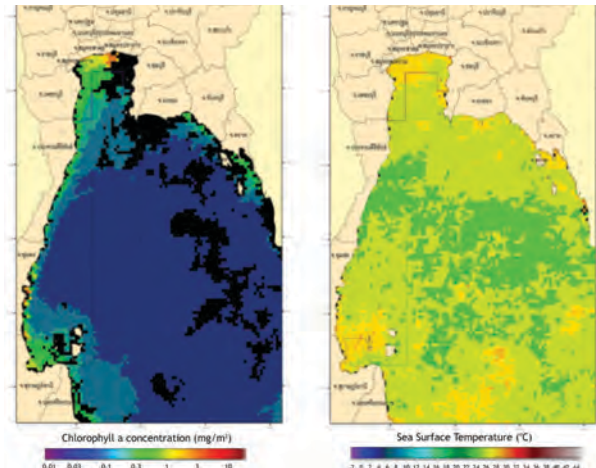


Figure 8. Chlorophyll-a (left) and sea surface temperature (right) in the Gulf of Thailand using satellite data

• Age and Growth Determination of Indo-Pacific Mackerel Using Otolith Microstructure Technique

Otolith shape analysis technique which makes use of the otolith contour to classify the stock is considered more efficient than using morphological parameters. Firstly, the Otolith Microstructure Technique was used to determine the age and growth of Indo-Pacific mackerel. The research made use of two stocks (Gulf of Thailand and Andaman Sea) and considered the assumption that fish in different environments will have different growth pattern. Using t-test and multivariate analysis of variance, the results led to the conclusion that the sequence genetic identifier of the Andaman Sea stock was significantly higher than that of the Gulf of Thailand. Results also showed that the parameter of Von Bertalanffy Growth Function could be used to describe the growth rate in relation to the otolith size while the exponential model could be used to convert the total length to age, assuming that the fish continue to grow for infinitely long period of time. Secondly, the otolith microchemistry approach was used to classify the stock of short mackerel for the development of an effective regulation and management regime.

• Stock Identification of Short Mackerel in the Gulf of Thailand by an Otolith Microchemistry Approach

An Otolith Microchemistry Approach is one of the methods used for stock identification of short mackerel in the Gulf of Thailand. This study is aimed at understanding the stock structure of *Rastrelliger brachysoma* in the GoT using otolith microchemistry as a classification method. The otolith was analyzed by extracting the microelement components such as lithium (Li), magnesium (Mg), manganese (Mn), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), strontium (Sr), barium (Ba), and uranium (U), and were normalized to calcium (Ca). For the analysis, MANOVA and Principal Component Analysis (PCA) were used to display the microchemical data of the sectioned otolith materials and detect the stock differentiations among the sampling sites and examine the relative importance of each variable, *i.e.* Linear Discriminate Function Analysis (LDFA) was used to classify individual fish with respect to their collection areas using micro-chemical values at the edge of the otolith sections and the whole otolith. The results showed that there are four (4) stocks of *R. brachysoma* in the Gulf of Thailand, *i.e.* Eastern, Upper, Central and Lower stocks. Members in each stock comprised individual fish from different origins of the larvae but grouped together, at least by 41 % (male) and 67 % (female) in their life span.

could be used as a scientific basis for *refugia* establishment and for coordination of management plans and measures. It was also proposed that the ASEAN Catch Documentation Scheme (ACDS) be established in the sub-region to have a compatible data scheme among GoT countries through the initiative of SEAFDEC. Moreover, as means of sharing information on transboundary species between the countries (especially between Thailand and Viet Nam), a formalized agreement on cooperation such as MoU, MoA or other format should be developed. High-level dialogue meeting was also encouraged to formally agree on the areas and objectives for cooperation.

As a means of managing transboundary species, the SEAFDEC and GoT countries have been conducting research activities in order to come up with an agreement on coordinated fisheries management measures. The DNA study for Indo-Pacific mackerel was aimed at understanding the stock structure in the sub-region and for the results to be used as a science based information in support of future management plans. Furthermore, development of joint management plan for Indo-Pacific mackerels in the GoT has been pursued to ensure the sustainability of the resources based on the available scientific evidence.

Acknowledgement

We, the Members of the 2019 Regional Fisheries Policy Network, were tasked to compile the information and make a synthesis on the Indo-Pacific mackerel in the Gulf of Thailand as part of our special assignment, based on the Report of the Gulf of Thailand Technical Meeting on Management of Transboundary Species: Indo-Pacific Mackerel, in Bangkok, Thailand on 19-20 December 2018. We would therefore wish to express our sincerest gratitude to the representatives from participating countries, namely: Cambodia, Malaysia, Thailand, and Viet Nam for providing valuable inputs that went into the Report, which we used in our compilation. We also extend our special gratitude to the experts and resource persons from Kasetsart University, namely: *Dr. Akarapong Swatdiponga*, *Dr. Sirthorn Kongsenga*, *Dr. Tanuspong Pokavanich*, *Dr. Methee Kaewnern* and *Ms. Ratanawalee Phoonsawat*, and also to *Dr. Pavarot Noranarttragoon* from the Department of Fisheries of Thailand, for their valuable information and insights on the management of the fisheries of this species. We also offer our big thanks to the staff of SEAFDEC Secretariat, especially to *Dr. Worawit Wanchana* for his support and guidance, and to the researchers from SEAFDEC/MFRDMD and SEAFDEC/TD for their technical advice during the synthesis and analysis of the information included in this compilation.

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Towards the Sustainable Management of Purse Seine Fisheries in Southeast Asia

Mohammad-Faisal Md Saleh, Wahidah Mohd Arshaad, Raja Bidin Raja Hassan, Katoh Masaya, Abdul Razak Latun, Nurul Nadwa Abdul Fatah, and Khairiah Jaafar

The Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2020 (SEAFDEC, 2011) adopted during the ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security Towards 2020 "Fish for the People 2020: Adaptation to a Changing Environment" in 2011, includes Resolution No. 10 on the need to "Strengthen knowledge/science-based development and management of fisheries through enhancing the national capacity in the collection and sharing of fisheries data and information," and Resolution No. 22 to "Establish and strengthen regional and sub-regional coordination on fisheries management and efforts to combat IUU fishing including the development of regional/sub-regional Monitoring, Control and Surveillance (MCS) networks." These Resolutions have also been directed towards the development of management strategies for sustainable fisheries, more particularly, purse seine fisheries which is one of the most practiced fisheries in the Southeast Asian region. In responding to such Resolutions, the Malaysia-based SEAFDEC Marine Fisheries Resources Development and Management Department (SEAFDEC/MFRDMD) implemented the project "Comparative Studies on the Management of Purse Seine Fisheries in the Southeast Asian Region" from 2013 to 2019, in cooperation with the SEAFDEC Secretariat and SEAFDEC Training Department. With funding support from the Japanese Trust Fund, the Project involved eight participating ASEAN Member States (AMSs), namely: Brunei Darussalam, Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Thailand, and Viet Nam; and was aimed at coming up with: 1) an analysis of the historical data on catch and effort of purse seine fisheries among the AMSs; 2) evaluation of the purse seine fisheries management systems among the AMSs; and 3) a review of the genetic structure of commercially-important small pelagic fishes targeted by purse seine.

In the Southeast Asian region, purse seine fisheries (**Figure 1**) existed since the nineteenth century (Morgan & Staples, 2006; Raja Bidin & Abdul Razak, 2016). Purse seine is usually operated with the use of fish aggregating devices, luring lights, and other devices to exploit the small pelagic fishes. The several types of purse seine include fish purse seine, anchovy purse seine, Thai purse seine, luring purse seine, and tuna purse seine. Nowadays, modern purse seine vessels are equipped with radar, depth sounder, sonar transceiver, and satellite navigational instruments (SEAFDEC, 2017). The statistical report in 2016 indicated that purse seine fisheries contributed 30.5 % to the total marine capture fisheries production of Southeast Asia, reflecting the significance of purse seine fisheries as the most productive gear in the region after trawl.

Through the years however, the expansion of purse seine fishery in the region was unregulated (Morgan & Staples, 2006) resulting in the overexploitation of small pelagic fish resources. The catch of small fishes gradually decreased from 3.7 million t in 2010 (Abu Talib, *et al.*, 2013) to 3.5 million t (SEAFDEC, 2017). Management of the purse seine fisheries had been neglected because of inadequate information on stocks and biological characteristics of the small pelagic fish resources. It has therefore become necessary to develop management strategies for the sustainable purse seine fisheries in the region, and address the relevant Resolutions that call for the sustainable management of the region's fisheries.

Considering its mandate, SEAFDEC/MFRDMD was therefore tasked to review the purse seine fisheries management systems and other fisheries management measures in other parts of the world to determine the management systems and measures that would be applicable for the Southeast Asian region. Meanwhile, it was also deemed necessary that genetic studies of the small pelagic fishes be carried out to verify the extent of the connectivity of commercially-important pelagic fish species targeted by purse seine fisheries, and provide scientific



Figure 1. Purse seine fisheries in the Southeast Asian region

background for concerted management actions of the AMSs for shared stocks of small pelagic fish species.

Investigation of the Purse Seine Fisheries in Southeast Asia

Stock assessment

At the outset, stock assessment was carried out using simple and holistic methods which can be either a fishery-independent or fishery-dependent data survey, especially in situations where the data are limited, as in the case of most AMSs. All these methods of data collection have been widely used to assess the pelagic fishery resources in the Southeast Asian region since 1970s. The fishery-dependent data combined with data from fishery-independent surveys would provide a more accurate picture of the stock status. Thus, attempts were made to determine the stock status of small pelagic fishes in the region using a standard method applicable to all AMSs to generate harmonized results.

The respective 20-year data on purse seine fisheries provided by the participating AMSs, were analyzed and harmonized during the Core Expert Meetings and Regional Workshops organized by SEAFDEC/MFRDMD between 2014 and 2018. In order to calculate the catch per unit effort (CPUE), fishing effort by number of trips was chosen as the unit of effort since the data on hauls or days per trip of most AMSs were lacking. The data on number of trips was more stable compared to the fishing effort by number of purse seine vessels. The calculated CPUE was used in the Production Model analyses to illustrate the stock status of small pelagic fishery resources particularly for the AMSs with adequate catch and effort data. The Fox Model was used because its r^2 values are more precise than the Schaefer Model. For Feedback Control (Rule 2-2), the analysis was done at country and sub-region levels. For countries with scarce data, the allowable biological catch (ABC) value was estimated at the country level.

Genetic study

Sardines are among the groups of small pelagic fish species that are highly targeted by purse seine fisheries in the Southeast Asian region. Among the sardines species, the spotted sardinella (*Amblygaster sirm*) (Figure 2) was selected for genetic studies as these are easily distinguishable from among the various species, and thus misidentification



Figure 2. Spotted sardinella (*Amblygaster sirm*)



Figure 3. Sampling sites for genetic study of the spotted sardinella, *Amblygaster sirm*

could be avoided during the sampling. Sardines are widely distributed in the Southeast Asian waters but information on the various species remains limited. To determine its genetic stock structure, the spotted sardinella was subjected to mitochondrial DNA (mtDNA) analysis to ascertain whether this species exist both in the South China Sea (SCS) and Andaman Sea (ANS) or the population is panmictic which is characterized by random mating within a breeding population. During 2014-2018, samples of *A. sirm* were collected from the SCS sub-region (six sampling sites), Gulf of Thailand sub-region (one sampling site), ANS sub-region (two sampling sites), and from Java Sea (one sampling site) (Figure 3).

Dominant small pelagic fishes

Further analysis of the compiled data from the AMSs, indicated that there are other dominant small pelagic fish species that have also been targeted by purse seine fisheries in the Southeast Asian region in 1996-2016. Aside from sardines, the other species include among others, anchovies, Indo-Pacific mackerel, round scad, neritic tunas, Indian mackerel, selar scad, and hardtail scad (Figure 4). On the other hand, the fish species that could not be identified were grouped as other pelagic fishes. Mixed fish are small-size fish that are

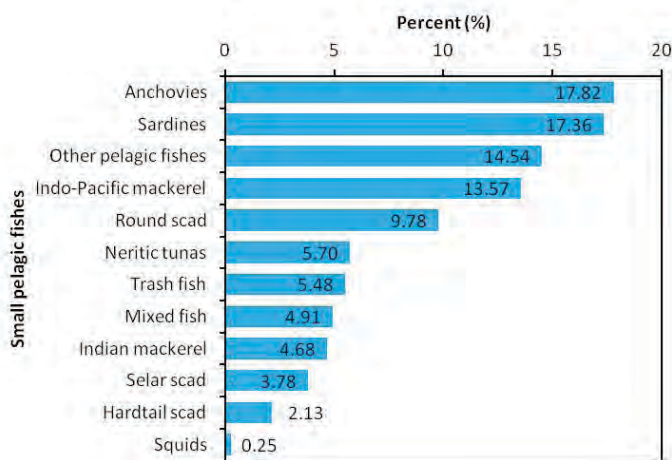


Figure 4. Dominant small pelagic fish species caught by purse seine in the Southeast Asian region during 1996-2016

fresh but has lower price, thus, it is processed into value-added products such as fish crackers, fish balls, and others. Trash fish are small-size fish that are no longer fresh because of the long duration of trip in the sea, thus, it is used as feeds for animals, aquaculture as well as agriculture fertilizer.

Purse seine fisheries management

The purse seine fisheries management systems among the participating AMSs were compiled and the methods in assessing their respective fishery resources, as well as the existing fisheries laws and regulations related to purse seine fisheries in respective countries were analyzed (Table 1). Currently, licensing of purse seine vessels is compulsory in all AMSs, which is renewable either annually or biennially. The licensing scheme encompasses various aspects such as

Table 1. Synthesis of the stock assessment methods and purse seine fisheries management measures adopted by the AMSs

Country	Stock assessment methods	Management measures
Brunei Darussalam	Catch and effort data collection from 2001 to 2013	<ul style="list-style-type: none"> Licensing scheme Monthly catch logbooks Fishing zonations Minimum seine mesh size No take zones Marine protected areas (MPAs)
Cambodia	Catch and effort data collection on mackerels (<i>Rastrelliger</i> spp.) from 1992 to 2006	<ul style="list-style-type: none"> Licensing scheme Fishing logbooks Annual closed season for <i>Rastrelliger</i> spp. MPAs
Indonesia	Acoustic survey in Fisheries Management Area 711 in the SCS in 2016	<ul style="list-style-type: none"> National Fishery Policy Fishery Management Plan (FMP) Licensing scheme Fishing zonations Fishing license moratorium Minimum seine mesh size Control light density Closed seasons Closed areas MPAs Marine Managed Areas (MMAs)
Malaysia	Acoustic surveys in West Coast of Peninsular Malaysia in 2013, East Coast of Peninsular Malaysia in 2013-2014, and Sarawak and Sabah in 2015	<ul style="list-style-type: none"> Licensing scheme Fishing zonations Control on size and power of fishing vessels Minimum seine mesh size Monitoring, Control and Surveillance Program Resettlement of surplus fishers to other sectors No take zones Identify nursery grounds in areas within 5 nm from the shoreline MPAs Marine Park Fisheries Prohibited Area (FPA) <i>Refugia</i> site

Table 1. Synthesis of the stock assessment methods and purse seine fisheries management measures adopted by the AMSs (Cont'd)

Country	Stock assessment methods	Management measures
Myanmar	Simultaneous hydro-acoustic and trawl sampling (swept area method) using the research vessel Dr. Fridtjof Nansen in 1979, 1980, 2013, 2015, and 2018	<ul style="list-style-type: none"> Licensing scheme Fishing zonations Moratorium on fishing licenses Annual closed season Closed fishing areas MPAs Identify nursery grounds as reserved fishing areas FPA including 3 nm around the islands
Philippines	National Stock Assessment Program (NSAP) in 2015	<ul style="list-style-type: none"> FMP Licensing scheme Fishing logbooks Minimum seine mesh size Fisheries Observers' Program Closed season for sardines Annual catch ban of some pelagic fish species Annual closed fishing season for round scad MPAs
Thailand	Fox Surplus Production Model for pelagic fishes and anchovies for all fishing gears in Thai waters in 2017 and 2018	<ul style="list-style-type: none"> National Policy for Marine Fisheries Management 2015-2019 FMP Licensing scheme Control on size and power of fishing vessels Allowable fishing days Minimum seine mesh size Monitoring, Control and Surveillance Program Resettlement of surplus fishers to other sectors Moratorium on fishing license Annual closed fishing season Closed fishing areas MPAs
Viet Nam	Acoustic survey of small pelagic fishes in 2012-2013 and comprehensive survey in Viet Nam Sea from 2011 to 2015	<ul style="list-style-type: none"> Licensing scheme Fishing logbooks Minimum seine mesh size Monitoring, Control and Surveillance Program Catch Monitoring Program MPAs

regulations on vessel tonnage, engine power, mesh size, seine net length, among others.

Stock assessment analysis: Production (Fox) Model

Initially, the total allowable catch (TAC) was considered as one of the management measures to be adopted during the stock assessment. However, it was found that TAC was not applicable as the compiled data was inadequate to comply with the requirements of the TAC system. Moreover, the TAC system is not suitable for the multi-species situation of purse

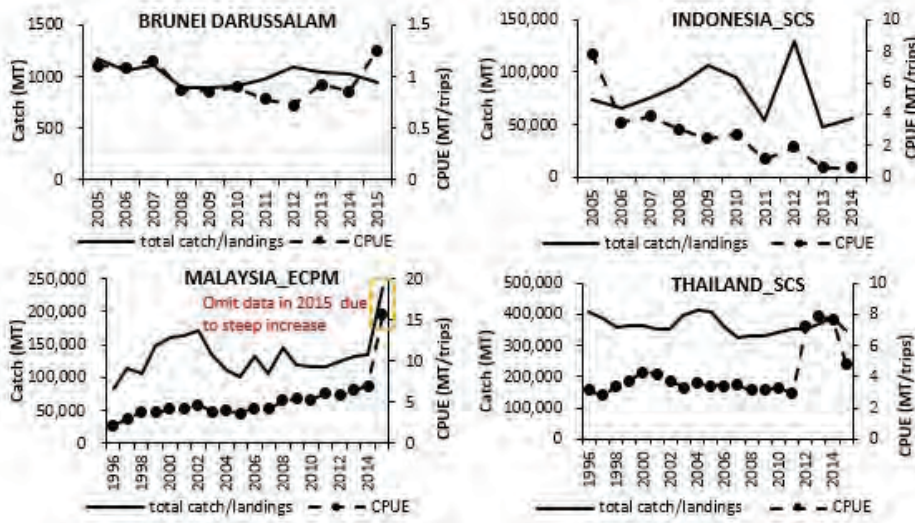


Figure 5. Trend of CPUE by trip of purse seine fishery for the countries in the South China Sea sub-region in 1996-2006

Table 2. Estimated MSY and target fMSY by Fox model for the countries in the South China Sea (SCS) and Andaman Sea (ANS) sub-regions

Country	Sub-region	Year	Current catch (MT)	Current effort, trips	r ²	MSY		Target fMSY		Deficit/surplus	%
						MSY (MT)	fMSY	0.8 fMSY			
Brunei Darussalam	SCS	2005-2015	949	758	0.7061	1,045	1,319	1,055	96	9.2	
Indonesia	SCS	2005-2014	56,128	89,562	0.8641	95,147	35,971	28,777	39,019	41.0	
Malaysia	SCS (ECPM)	1996-2014	134,979	19,210	0.5828	131,679	35,211	28,169	-3,300	-2.5	
Thailand	SCS	1996-2015	347,960	71,754	0.8876	382,926	89,286	71,429	34,966	9.1	
	ANS	1996-2015	134,203	59,138	0.8744	165,008	75,188	60,150	30,805	18.7	

seine fisheries in the region. Thus, the Production (Fox) Model and Feedback Control (Rule 2-2) was used instead.

Apparently, in the SCS sub-region, Brunei Darussalam had the most stable trend of CPUE during 2005-2015. Malaysia and Thailand also showed stable trend of CPUE in 1996-2015 but drastically changed at latter years.

Indonesia on the other hand, had a decreasing CPUE over the years (2005-2014) despite of having high catch from purse seine fleets (Figure 5). The current fishing effort (F, by trip) in Indonesia in the SCS sub-region had already extremely exceeded the estimated target fMSY level, thus, it is assumed that the pelagic fish stock in that area was long overfished and would collapse in the future if the trend of excessive fishing effort continues. For Brunei Darussalam, the estimated MSY and target fMSY level showed that its pelagic fishery resources are at sustainable level (Table 2). Meanwhile, the Malaysian (East Coast of Peninsular Malaysia or ECPM) pelagic resource is currently fully-exploited since the estimated MSY level was already reached in 2014. The current effort for Thailand, in the SCS and ANS, had already reached the estimated fMSY level in 2015. Based on the estimated MSY and fMSY values, it is recommended that the fishing effort in Indonesia should be decreased and the current fishing effort in Malaysia and Thailand should not be increased for the sustainability of pelagic fisheries.

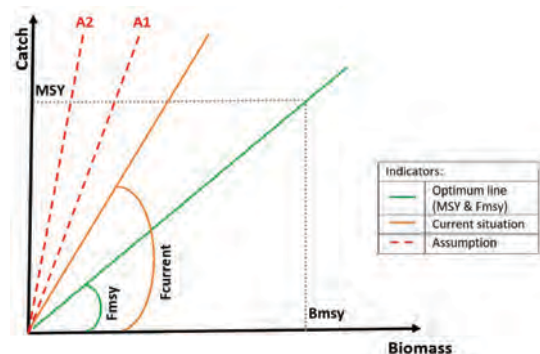


Figure 6. Biomass and catch for purse seine fishery in Indonesia in the South China Sea

(Source: SEAFDEC/MFRDMD, 2019)

In Figure 6, the current situation of the stocks for purse seine fisheries in Indonesia is represented by orange line. This indicates that if the effort by trip increases, the orange line will reach A1. Further increasing of the effort, the line would coincide with A2, and eventually approaches the Y axis. The biomass would become very low considering that the biomass reduces as effort increases. However, the situations would be different when the effort decreases. The MSY (green line) and BMSY (black broken line) values are at the optimum level. In general, when the effort is decreased, the orange line will approach or even go lower than the green line. During this time, the biomass value could recover and increase since the effort is reduced.

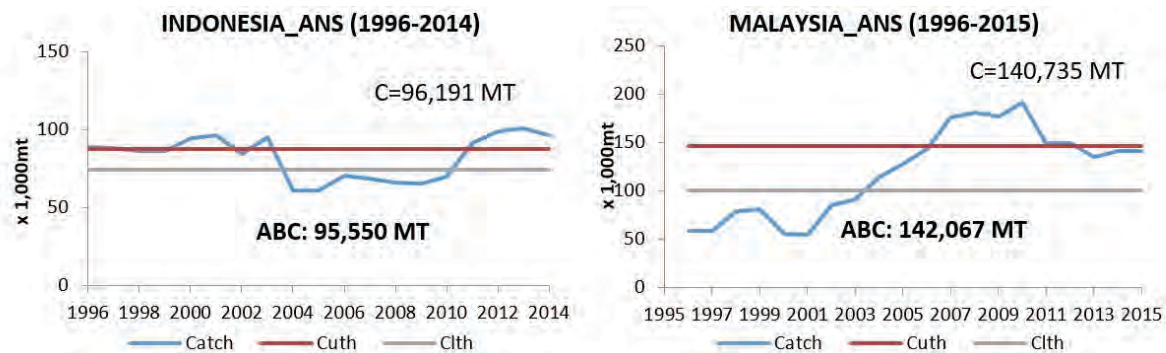


Figure 7. Feedback control analysis (Rule 2-2) for purse seine fisheries in Indonesia (ANS) and Malaysia (ANS) (ABC: allowable biological catch; C: current landing; Cuth: catch upper threshold; Clth: catch lower threshold)

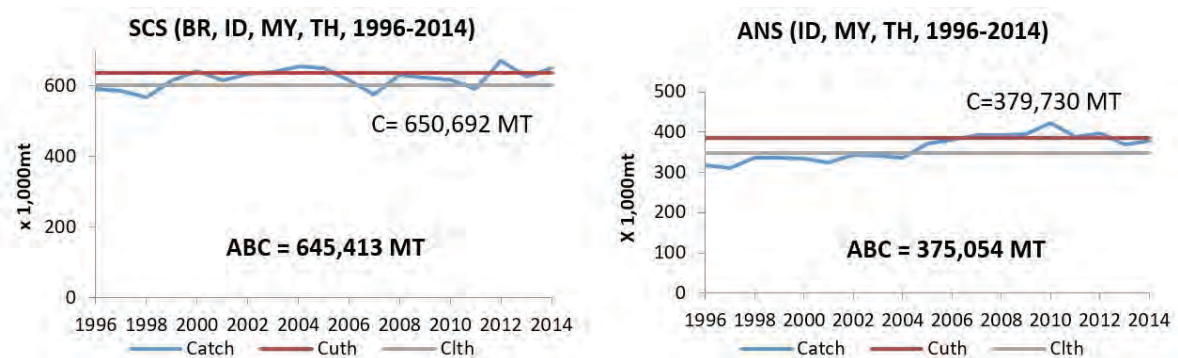


Figure 8. Feedback control analysis (Rule 2-2) for purse seine fishery in SCS and ANS sub-regions (ABC: allowable biological catch; C: current landing; Cuth: catch upper threshold; Clth: catch lower threshold)

Stock assessment analysis: Feedback Control

The Feedback Control (Rule 2-2) analysis was done at country and sub-region levels. The allowable biological catch (ABC) value at country level was estimated only for Indonesia in the ANS and Malaysia also in the ANS which have scarce data. Since each country had different systems for collecting statistical data and information, the analysis at country level was considered to be more appropriate. The result of the analysis showed that the pelagic stock in Indonesia (ANS) and Malaysia (ANS) were sustainably exploited (Figure 7). Although the analysis at sub-region level showed that the current catch in 2014 had already reached the estimated ABC for SCS (Brunei Darussalam, Indonesia, Malaysia, Thailand) and ANS (Indonesia, Malaysia, Thailand) sub-regions, it is assumed that the pelagic resources in SCS and ANS are still sustainable (Figure 8).

In reality however, the accuracy of the analyses at sub-region level is uncertain because not all AMSs were included and the data were highly dispersed and imprecise. Also, it should be noted that the ABC analyses at country and sub-region levels may not represent the status of pelagic fisheries in the region in 2019 since the available catch data was until 2014 or 2015 only, thus, the present status might be different from the results of the ABC analyses. Consequently, the comprehensive evidence that would assist stakeholders in developing the

fisheries management plan at sub-region level, could not be provided.

Therefore, for sustainable purse seine fisheries, it is recommended that the Surplus Production Model should be used to determine the optimum level of effort (fMSY), especially when the catch and effort data are sufficient and reliable. However, if the data is not sufficient, Feedback Control (Rule 2-2) which determines the ABC could be used

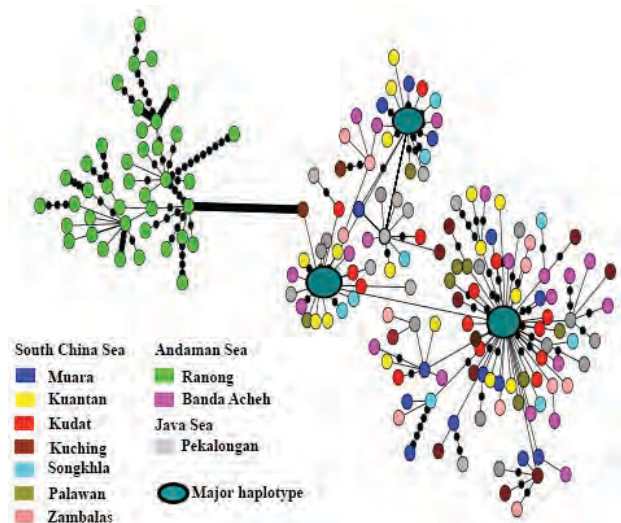


Figure 9. Minimum spanning network inferred from mtDNA Cytochrome b gene

instead of TAC system because of the multispecies nature of fisheries in the region.

Genetic stock structure

During 2014-2018, a total of 498 samples of *A. sirm* were obtained from the SCS sub-region, Gulf of Thailand sub-

region, ANS sub-region, and Java Sea. Based on the genetic analysis, both DNA markers, Cytochrome b (**Figure 9**) and Cytochrome c Oxidase Sub-unit I (COI) (**Figure 10**), revealed two highly genetic divergent stocks. One stock is in the northern ANS (*i.e.*, Ranong) while the rest of the populations could be found in the SCS (*i.e.*, Muara, Kuantan, Kuching, Kudat, Palawan, Zambales, and Songkhla), southern ANS

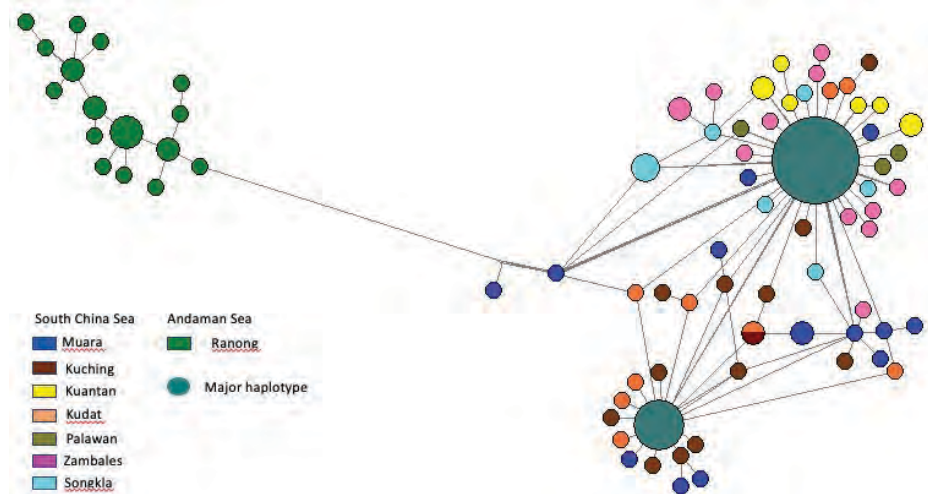


Figure 10. Minimum spanning network inferred from mtDNA COI gene

Box 1. Issues and recommendations for sustainable purse seine fisheries management in the Southeast Asian region

Issues	Recommendations
Data collection	<ul style="list-style-type: none"> • Improve data collection especially on catch and effort <ul style="list-style-type: none"> - collecting timely and accurate data - adopting the standard format of data reporting prescribed by the Project to enable sound statistical analysis - adopting harmonized stock assessment methods (Production (Fox) model analysis, Feedback control analysis, among others) - complying with the standard procedures of data sharing as agreed among AMSs
Input controls (fishing capacity)	<ul style="list-style-type: none"> • Assess and control fishing capacity <ul style="list-style-type: none"> - regulating fishing capacity through fishing licenses and catch quotas • Enhance the licensing scheme of purse seine vessels <ul style="list-style-type: none"> - controlling the number of purse seine vessels - limiting the size of purse seine vessels - restricting the number of fishing days
Output controls (catch)	<ul style="list-style-type: none"> • Enforce catch quota system <ul style="list-style-type: none"> - applying total allowable catch (TAC), but there are difficulties in implementing successful catch quota system - applying individual quota (IQ) which indicates a quota allocated to an individual fisher • Improve handling of bycatch (non-target species) <ul style="list-style-type: none"> - promoting the recommendations of the Bycatch Management Information System which include the safe release technique of sea turtles, sharks, and rays
Technical controls	<ul style="list-style-type: none"> • Restrict the design of fishing gear and accessories <ul style="list-style-type: none"> - limiting the length and depth of seine net - enlarging mesh size - reducing the intensity of fish luring lights - registering and controlling the number of fish aggregating devices • Regulate the fishing grounds and seasons <ul style="list-style-type: none"> - establishing a zoning system including closed area for specific species - implementing closed season for concerned species
Management measures	<ul style="list-style-type: none"> • Review the legal frameworks periodically <ul style="list-style-type: none"> - developing fisheries management plan • Support the monitoring, control and surveillance (MCS) activities <ul style="list-style-type: none"> - upgrading the MCS capability among national enforcement agencies - strengthening the MCS network among the AMSs within the same sub-region • Develop the capacity of human resources <ul style="list-style-type: none"> - conducting regular capacity building activities - promoting co-management among fisheries stakeholders (government, non-government organizations, private sector, fishing community, among others)

(Banda Aceh), and Java Sea (Pekalongan). Since *A. sirm* could not be found in the Strait of Malacca (Carpenter & Niem, 1999), it is suggested that each stock should be managed independently. Further study is recommended to confirm the genetic stock structure of the spotted sardinella being a cryptic species in Ranong.

Recommendations

Based on the foregoing analyses of the stock assessment, the issues had been identified and recommendations provided (**Box 1**) for possible adoption by the AMSs for effective management of purse seine fisheries in the Southeast Asian region, as appropriate.

Way Forward

SEAFDEC/MFRDMD would continue its collaboration with the AMSs and relevant organizations for the new project on shared stocks “Fisheries Management Strategies for Pelagic Fish Resources in the Southeast Asian Region” under the JTF 6 Phase II. In this new project, in-depth fisheries analyses would be pursued. The focus of the Project would be on regional stock and risk assessment, as well as on the current status of targeted pelagic fish species in the South China Sea and Andaman Sea. Genetic study to clarify genetic structures as well as otolith analysis to determine life-history of selected neritic tuna species would also be conducted.

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Learning from an EAFM Pilot Application: a case in Trapeang Ropov Village, Kampot Province, Cambodia

Panitnard Weerawat, Supin Wongbusarakum, Leakhena Chin, and Chanpraseth You

The 1995 FAO Code of Conduct for Responsible Fisheries (CCRF) includes provisions that call for the promotion of an Ecosystem Approach to Fisheries Management (EAFM) (FAO, 1995). As signatory to the CCRF, the ASEAN Member States (AMSS) recognized that the promotion of EAFM concept is crucial in the region, and agreed to promote EAFM in the Southeast Asian region in accordance with the adopted the ASEAN-SEAFDEC Resolution and Plan of Action on Sustainable Fisheries for Food Security Towards 2020 “Fish for the People 2020” (SEAFDEC, 2011). Specifically, Resolution No. 6 encourages SEAFDEC and the AMSS to “Implement effective management of fisheries through an ecosystem approach to fisheries that integrates habitat and fishery resource management aimed at increasing the social and economic benefits to all stakeholders, especially through delegating selected management functions to the local level and promoting co-management as a partnership between government and relevant stakeholders,” while Plan of Action (POA No. 8) directs SEAFDEC and the AMSS to “Accelerate the development of fisheries management plans based on an ecosystem approach, as a basis for fisheries conservation and management,” and POA No. 10 to “Establish and implement comprehensive policies for an ecosystem approach to fisheries management through effective systems – (i) to provide licenses to fish (boats, gear and people); (ii) for community fishing rights/rights-based fisheries; (iii) that provide for the development of supporting legal and institutional frameworks; (iv) that encourage institutional cooperation; and (v) that aid in streamlining co-management.” For the part of SEAFDEC, the EAFM concept had been promoted in different ways in several AMSS in collaboration with other regional and international organizations to enable the AMSS to boost the development of sustainable and responsible fisheries in their respective countries.

During 2013-2019, the SEAFDEC Training Department (SEAFDEC/TD) implemented the project “Human Resource Development for Sustainable Fisheries” to address the priority actions stipulated in the ASEAN-SEAFDEC Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2020, which received funding support from the Japanese Trust Fund (JTF). Under this Project, the EAFM concept had been piloted in selected AMSS (Weerawat and Worranut, 2019), and in 2017 the EAFM concept was introduced in Cambodia as one of the pilot sites of the Project. Upon completion of the activity in the pilot learning site in Cambodia, key achievements were attained. These include: 1) establishment of the EAFM core team; 2) integration of EAFM in the fishery management plans at community level; 3) enhanced capability of the EAFM core team to organize EAFM training courses; 4) strengthened capacity of the Fisheries Administration (FiA) officers

and local fishers in advocating ecosystem conservation; and 5) broadened coverage of fisheries management, *i.e.* the ecosystem, stakeholders, alternative livelihoods, and governance.

The EAFM Concept

The Ecosystem Approach to Fisheries Management (EAFM) is a practical and participatory way to manage fisheries by continually striving to achieve a balance between the ecological and human well-being through good governance. FAO defines the Ecosystem Approach to Fisheries (EAF) as “an approach to fisheries management and development that strives to balance diverse societal objectives, by taking into account the knowledge and uncertainties about biotic, abiotic, and human components of the ecosystems and their interactions, and applying an integrated approach to management of fisheries within ecologically meaningful boundaries” (FAO, 2003).

EAF endeavors to plan, develop, and manage fisheries in a manner that addresses the multiple needs and desires of diverse stakeholders and the broader societies, without jeopardizing the options for future generations to benefit from the full range of goods and services provided by the ecosystems (Garcia *et al.*, 2003; FAO, 2003; FAO, 2012; Heenan *et al.*, 2015). Effective and equitable management measures need to take into account good governance and ecosystem dynamics of which people are an important part (Figure 1). Furthermore, the practical implementation of an EAFM revolves around a cycle of five steps after the initial preparation phase (Box 1).

Box 1. Five steps in implementing the Ecosystem Approach to Fisheries Management

- Step 1: Define the scope of the Fisheries Management Unit
- Step 2: Identify and prioritize the goals
- Step 3: Develop an EAFM plan
- Step 4: Implement the plan
- Step 5: Monitor, evaluate, and adapt the EAFM



Figure 1. The EAFM components

EAFM Pilot Learning Site

The fishers living in or near the fishing areas in Cambodia have organized themselves into Community Fisheries (CFi) and have voluntarily established the initiatives to achieve their objectives (Box 2). Since its establishment in 2000s through a Sub-Decree, the CFi served as a major factor in building trust and fostering cooperation in the communities. The FiA and Commune Councils have worked together for the establishment of the CFi as an organization and continued to support their ongoing activities (FAO, 2017).

The EAFM pilot learning site of the Project was a transboundary area between Trapeang Ropov in Kampot Province and Prey Nup 2 in Preah Sihanouk Province (Figure 2). In 2017, the two fishing villages combined had 2,991 families with 835 fishing households and 300 fishing boats. The fishers depend on the 5,952-ha fishing area with fishery resources that include

Box 2. Objectives of the Community Fisheries (CFi) in Cambodia

- Management of inland fisheries and related ecosystems where the fishing lots have been cancelled
- Management of the fishery resources in sustainable and equitable manner
- Raising of the understanding and recognition of the benefits from fishery resources through participation in their protection and management
- Development and promotion of legal framework to establish community fisheries
- Improvement of the standards of living and reduction of poverty fishing communities

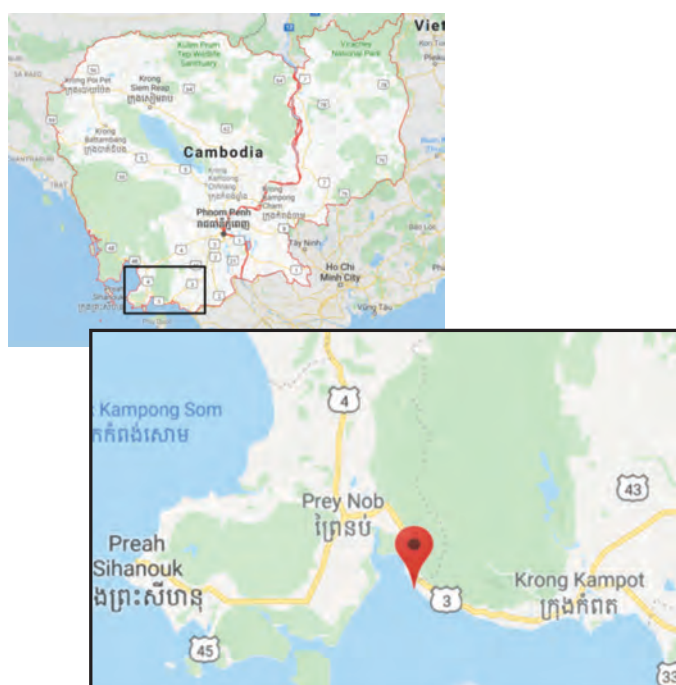


Figure 2. The Project's EAFM pilot learning site in the transboundary area between Trapeang Ropov in Kampot Province and Prey Nup 2 in Preah Sihanouk Province, Cambodia

Source: Google maps

fishes, blue swimming crabs, mangrove crabs, and blood cockles. Crab traps, mullet gill net, gill net, and push net are the major fishing gears used. The fishing area is also a habitat for endangered species such as dugong, sea turtles, and seahorses, and is also a tourist destination that had attracted the private sector for large-scale development.

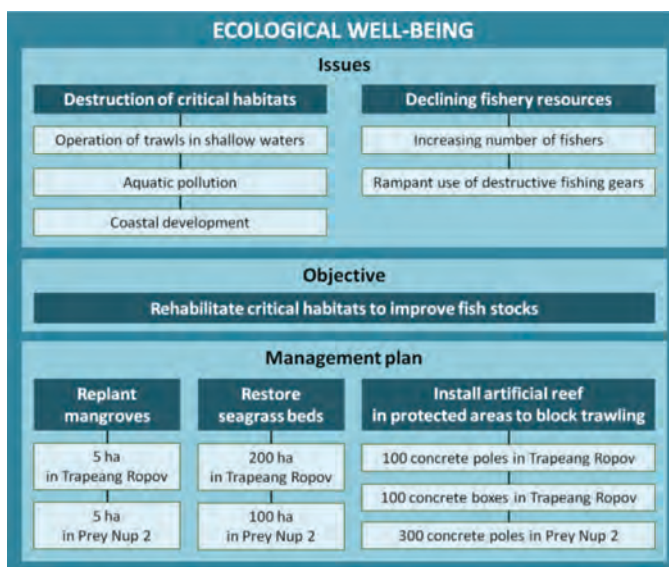
The CFi of Trapeang Ropov was established in 2002 along with the CFi of Prey Nup 2 to co-manage the transboundary fishery resources and coastal habitats including 698 ha of mangrove areas, 700 ha of seagrass beds, and 152 ha of blood cockle beds of which 15 ha had been allocated as conservation area. The Trapeang Ropov CFi is endowed with strong leaders who are actively involved in fisheries resource management activities and in complying with the fisheries regulations shared between the two neighboring coastal provinces.

Promotion of EAFM

Following the recommended steps in implementing the EAFM concept, SEAFDEC/TD in close collaboration with the FiA, organized several activities with the active involvement of the members of Trapeang Ropov CFi and representatives from other key stakeholders to consider the conditions of the EAFM pilot learning site. Based on the EAFM components, several issues were identified, the objectives of the pilot learning site were agreed upon, and management plans were developed for implementation.

Ecological well-being

Nonetheless, the EAFM pilot learning site had encountered multiple ecological issues including the destruction of critical habitats (*i.e.*, mangrove forests, seagrass beds, and coral reefs) as well as declining fishery resources. Therefore, the CFi of Trapeang Ropov exerted efforts to rehabilitate the habitats in order to increase the fish stocks. The management plan includes mangrove reforestation, seagrass restoration, and artificial reef installation.





Planting mangroves is one of the ecotourism activities in Trapeang Ropov, Kampot Province, Cambodia

Planting of mangroves was included as one of the ecotourism activities in the EAFM pilot learning site. Mangrove seedlings were propagated by the CFI and sold to tourists while educating them on the ecological importance of mangroves. The CFI put up signs to demarcate the areas of seagrass beds to be restored as well as installed concrete poles and artificial reefs to prevent the encroachment of trawlers in the protected areas. Although no scientific study was conducted, the CFI reported that the stocks of fish and crabs in the area had considerably improved. The report also indicated that the average catch of fishers has recently increased from 60 kg to 80 kg for fish and from 10 kg to 30 kg for crabs.

Human well-being

Many households in Trapeang Ropov are solely dependent on fisheries, but they earn low income and there had been no alternative livelihood opportunities for them. To alleviate the condition of the local fishers and enhance the human well-being in the EAFM pilot learning site, alternative livelihood opportunities were offered by developing first their capacities and supporting them in the production of local fishery products. Thus, a livelihood peer-exchange trip to Thailand was organized by the Project on 10-14 September 2018, for the

community leaders and representatives of Trapeang Ropov CFI to observe the fish sauce community enterprise in Rayong Province of Thailand.

After the trip, the CFI members started their own fish sauce production as an alternative livelihood in the EAFM pilot learning site. Large ceramic jars were provided by the Project for the eight CFI members who committed to pursue the production of fish sauce, which has become a great success, and the product has become popular with high demand. This has inspired the CFI members to boost their production by maintaining good quality and improving the packaging and eco-labeling. A local shop had been established for selling CFI products, particularly fish sauce. In addition, other local fishers also ventured on the production of dried fish and dried shrimps while some became involved in the mariculture of sea bass. Furthermore, ecotourism also served as another livelihood option in the EAFM learning site. The ecotourism services that include selling of seafood, tour guiding, and providing taxi boats had provided additional income to the local people and the community as a whole. The local fishers also learned to sell their catch directly to customers. Thus, the marketing system that used to be fully dependent on the middlemen, had shifted to direct selling and serving the needs of tourists.

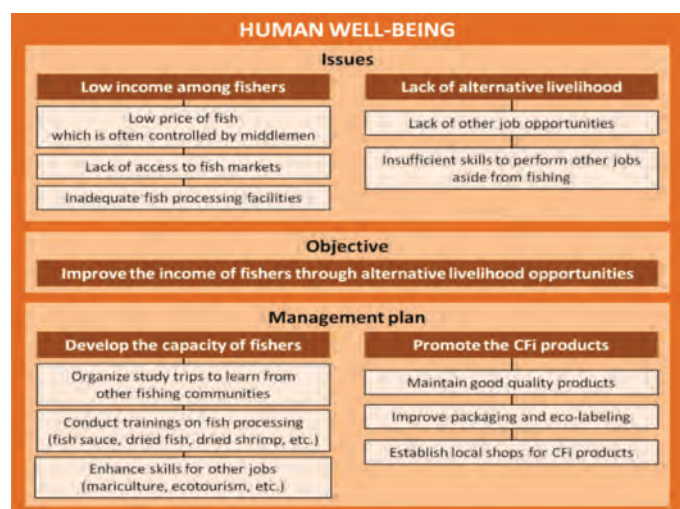


Fish sauce production trials at the Trapeang Ropov CFI

Good governance

While IUU fishing activities, particularly trawl fishing, had been prevalent in the waters of the EAFM learning site, the CFI of Trapeang Ropov took this as a challenge considering that the cooperation among relevant stakeholders had been inadequate to effectively manage the fishery resources while law enforcement to combat IUU fishing had been ineffective. To enable the CFI to execute good governance, they had to strengthen the cooperation among the relevant stakeholders in order to pursue sustainable fishery resource management effectively. Consequently, fostering cooperation among stakeholders and establishing an empowered joint patrol group had been considered their priority.

This led to the formation of the joint patrol group to combat IUU fishing in the EAFM learning site. The multi-stakeholder patrol group includes members from the two coastal provinces including the CFIs of Trapeang Ropov and Prey Nup 2, Community Council, Fisheries Administration Cantonment





(FiAC), the navy, marine police, provincial government, among others, and regularly convenes quarterly meetings. The marine police, who under competent authority, are able to carry arms for the purpose of enforcing the law on combating IUU fishing, started to have better understanding both of the need for enforcement support of the CFI and their own contribution to it. Law enforcement by the marine police plays a very important role for the CFI, which does not have the capacity to support and perform arrests. Now, the CFI can seek the help of the police to arrest offenders, and the marine police and key stakeholders have established partnership in successfully combating IUU fishing.

Lessons learned from the pilot learning site

The lessons learned from the EAFM implementation at the pilot learning site centered mainly on the stakeholders' increased participation in resource management, achievements of the multiple objectives, and strengthening of the cooperation and coordination among the various stakeholders.

Increased participation of stakeholders

In the EAFM principle, "increased participation" implies the need for stakeholders to become involved together and work effectively in both planning and implementation of the EAFM plans and activities. At the start of the promotion of EAFM in Trapeang Ropov, the draft EAFM plan was prepared by FiA, FiAC, and CFI. Since other relevant stakeholders, especially the fisherfolk were not involved in the planning process, it was difficult for them to understand the EAFM concept, and subsequently, became reluctant to take part in the conduct of management actions. Thus, the EAFM implementation was carried out only by the CFI with support from FiA and FiAC.

Fisheries management could not be successfully accomplished with only one or two stakeholder groups involved, therefore it was necessary for the EAFM activity to expand and considered the engagement of stakeholders through focal points, who

determine which stakeholder groups should be engaged in developing the management plans and then working actively for the implementation of the activities and monitoring the results. Several other agencies had been tapped to provide technical support to the EAFM activity in Trapeang Ropov, e.g. Fisheries Conservation Department, Department of Tourism, Department of Environment, provincial government, and the private sector.

Previously, national fisheries meetings did not involve the local communities but under the EAFM concept, the communities are now recognized as key partners in fisheries management. The increased participation of Trapeang Ropov CFI in managing the resources, conducting surveillance of illegal activities, and finding ways to improve their own livelihood has helped enhance ecological health and their human well-being. As the CFI members work together to rehabilitate the degraded ecosystems, the collective strength and social cohesion of the community had been reinforced and boosted.

Multiple objectives

Addressing "multiple objectives" takes into account the various agenda of different stakeholders and considers possible trade-offs. The EAFM principle also strives to balance the multiple, often conflicting, objectives relating to human and ecological well-being. However, competition among multiple objectives can occur not only between the ecological and human components, but also within the human component itself with different societal objectives. For example, there can be competing objectives between those who want to conserve resources for long-term sustainability and those who want to develop the site for economic gains, or between small-scale fishing community's well-being and large-scale coastal development in the CFI; or even the personal interests of those living inside and outside of the CFI.

Recognition of these multiple objectives is important when implementing an EAFM, and it is essential to fairly discuss and negotiate the trade-offs in a transparent way, taking the majority of the community as a whole into consideration. This is necessary as neither livelihood nor resource conditions could improve without good governance. Nevertheless, in the case of Trapeang Ropov, the most urgent EAFM component recognized was human well-being. The capacities and incomes of community members have been considered top priorities that need to be addressed first and foremost in order to get the community interested in working on the other two EAFM components.

Cooperation and coordination

In the EAFM principle, "cooperation and coordination" denotes voluntary but conscious and organized efforts of various stakeholder groups to work together to achieve the

EAFM objectives. Horizontal cooperation and coordination refer to efforts across sectors and agencies while vertical cooperation and coordination are across levels of government. While different FiA programs need to come together, the implementation of EAFM must also involve non-fisheries agencies and programs to better achieve the objectives of different EAFM components as well as to avoid any possible conflicts. These agencies include, for example, transportation, mining, environment, and tourism.

Considering that the responsibility of overseeing coordination should be that of a clearly designated party, the Community Fisheries Department (under FiA, FiAC, and CFi) had been identified by Trapeang Ropov as most appropriate to coordinate and mentor other stakeholder groups through strengthened collaboration, on how to effectively manage and implement plans. Different groups need to understand the contributions they could make for the successful EAFM plan that could benefit them. Nonetheless, cooperation and collaboration from conservation organizations are necessary to sustaining the resources, and support through partnerships with the private sector could initiate livelihood development.

Conclusion and recommendations

The EAFM concept has been considered as a useful tool that provides a holistic framework in the planning process of fisheries management in Trapeang Ropov. The implementation of the actions of the EAFM plan, although still in early stages, has demonstrated improved human well-being, restored ecological health, and strengthened cooperation among fisheries stakeholders in the EAFM learning site. However, it is also necessary that the EAFM plan should be well communicated among the relevant stakeholders to raise their awareness and for them to support and improve the activities. To date, more activities still need to be implemented although adequate funding support would be necessary. The Government of Cambodia has committed to increase the budget support to CFis and to decentralize the CFis from national to sub-national level. The proposed amendment of the country's Fisheries Law, particularly restricting open access and imposing strict penalties for large-scale fisheries, would allow the CFis to effectively enforce the regulations for reducing IUU fishing activities in their communities. Furthermore, the EAFM plan of the Trapeang Ropov CFi would be continued and expanded to the neighboring CFis. Although each EAFM learning site is different in terms of the issues and opportunities, the lessons learned from Trapeang Ropov CFi would be useful for other countries in the region in applying the EAFM concept.

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Assessing the Sustainability of Small-scale Inland Fisheries: a case of the fisheries in Barito River of Indonesia

Dina Muthmainnah and Aroef Hukmanan Rais

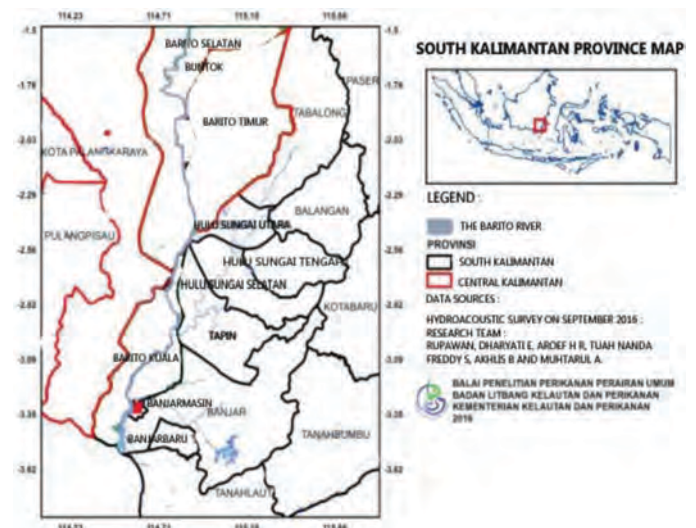
Indonesia is an archipelagic country with land area that is approximately two-thirds of the its waters, and embraces 7,508 large and small islands with a coastline that stretches to a total of about 81,000 km (Bengen, 2002). From among the ASEAN Member States, Indonesia has the widest area of inland waters encompassing approximately 54 million ha, of which about 71.63 % or 39.40 million ha comprises floodplains and swamps, 22.13 % rivers, and 3.89 % natural and artificial lakes, and 2.35 % other puddles/ water irrigation, which are mostly (60 %) situated in the Kalimantan provinces. The potential biological resources contained therein provide substantial contribution and benefits to the socio-economic well-being of the people of Indonesia, primarily as source of food and animal protein, and more particularly, as springboard of various business ventures for the inland fisheries communities. The country is also endowed with many big rivers, such as the Musi River, Kapuas River, Mahakam River, and Barito River. This article provides some information on the status of inland fisheries in Barito River.

fisheries, and also the whole of Kalimantan in general. Barito River is inhabited by no less than 207 species of fish and shrimps, although Utomo & Prasetyo (2005) reported that some species have been difficult to obtain, become rare, and their stocks have sharply declined.

Barito River and its Fisheries Features

Barito River is one of the major rivers in Indonesia with a length of about 900 km that originates from the Muller Mountain Range of North Kalimantan and flows from north to south traversing the island of Borneo to the mouth of Java Sea better known as Muara Banjar or Kuala Banjar (Figure 1). It is the most important river not only for Central Kalimantan but most especially, also for South Kalimantan Province (Figure 2) as the River in particular, services the province's requirements for transportation, recreation, livelihood, and

Figure 2. Barito River providing livelihood services to South Kalimantan Province



The several types of fish and shrimps that are of high economic value from the upstream to the estuary zone (downstream) in the course and flow of Barito River, include among others: *Macrobrachium rosenbergii*, *Pangasius djambal*, *Hemibagrus nemurus*, *Phalacronotus micronemus*, and various types of species from the Cyprinidae family such as *Thynnichthys*



Figure 1. Map of Indonesia (left) showing the provinces of Kalimantan and Barito River (right) that flows through Central Kalimantan to Java Sea

thynnoides, *Osteochilus schlegelii*, *Puntioplites falcifer*, and *Puntioplites bulu* (Rais & Wulandari, 2020).

Known for its rich tropical waters, Indonesia hosts multi-species inland fishery resources, but each species has been reported to have relatively few individuals left as results from the unsustainable use of various types of fishing gear, of which the types and their methods of catching, as well as the catch follow the nature of life and the fishing areas (Genisa, 1998). Each type of fishing gear generally has their particular catch and productivity target species, so that every kind of fishing equipment is not the same because it is strongly related to the type of fishing gear and the fishing methods used, and abundance of the target fish stocks (Kolding & Zwieten, 2014).

Most of the fishers appear to be less conscious of the modern capture fisheries techniques that are dovetailed towards sustainability. Considering that even nowadays, the fishers still continue to make use of traditional gear and craft, there is a need to promote useful initiative to establish suitable fisheries management policies gearing towards sustainable inland capture fisheries. This paper attempts to convey the state of small-scale fishers, their fishing operations, and income derived from the services provided by Barito River of Indonesia. By knowing the status of the River's fisheries, we could be assured that the fishery resources in Barito River could still continue to provide livelihoods to the poor fishers' communities in the area, and also lend suggestions to decision-makers for them to come up with the appropriate measures for improving the socio-economic well-being of the fishers' communities.

Fisheries Data Collection

With respondents who mainly come from the fishers' communities of Barito River in Kalimantan, Indonesia, primary data were collected through direct survey and interview of 25 fishers, while secondary data were obtained from related institutional reports and results of previous studies (Figure 3). The field surveys were conducted four times in a year from 2014 to 2016, to be able to obtain

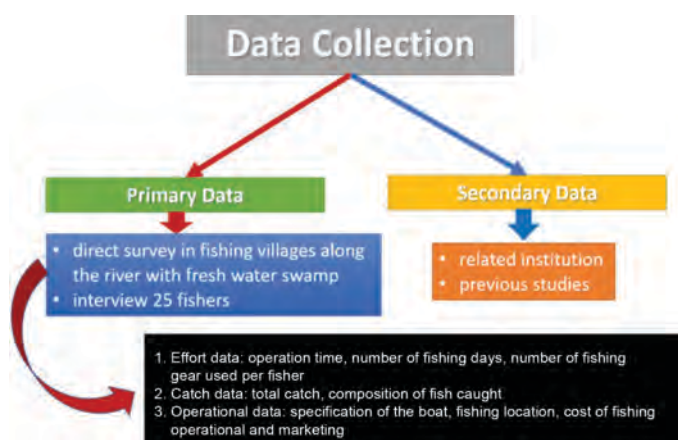


Figure 3. Fisheries data collection scheme adopted

representative data during the dry and wet seasons, as well as during the periods prior to the wet and the dry seasons. There are no fish landing sites along the River, so the fishers use their homes to transit their catch prior to selling this to markets or selling the catch to middlemen or for processing.

Based on the sample fishers and middlemen, designated enumerators collect the data that include the amount of fish caught every fishing operation and kind of fishing-gears used, and so on. Specifically, the primary data collected include: (1) Effort Data: operation time, number of days spent to catch fish, number of fishing gears used per fisher; (2) Catch Data: total catch, species composition of fish caught; and (3) Operational Data: specification of the boat, fishing location, operational costs incurred in fishing, and marketing.

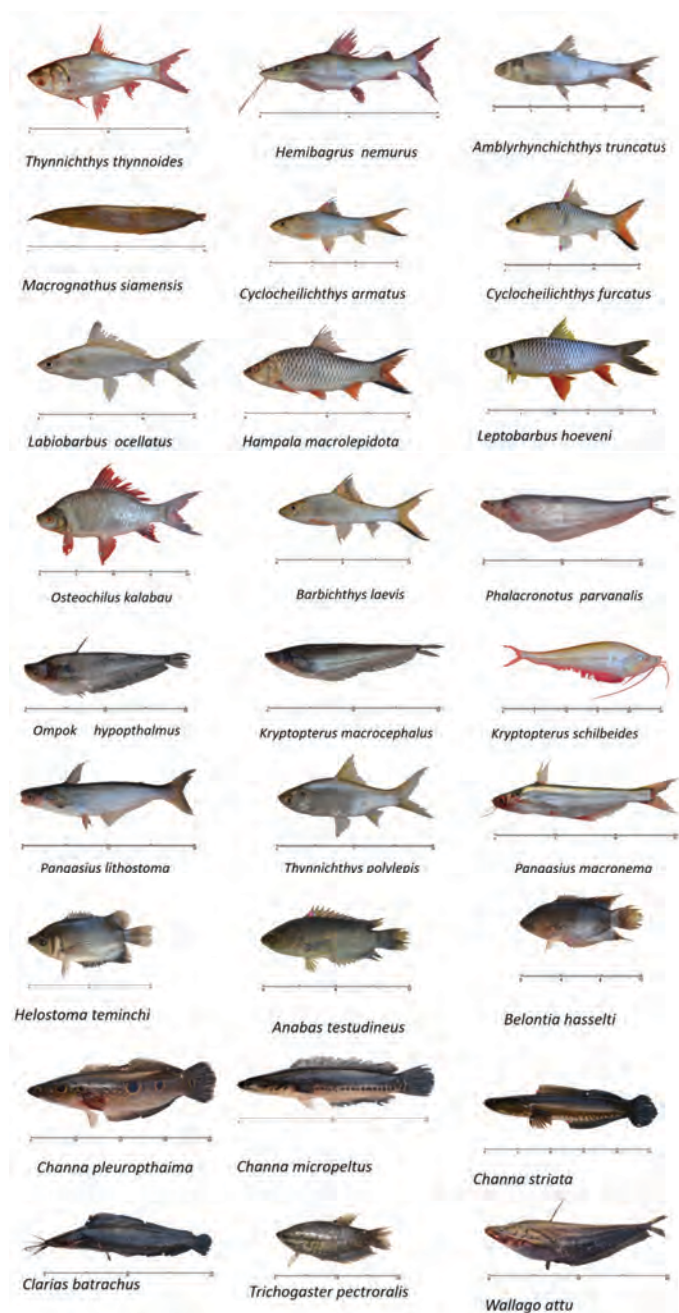


Figure 4. Some of the most economically important fishes that inhabit the Barito River of Indonesia

Fishery Resources Biodiversity

Results of the survey suggested that Barito River still has diverse fishery resources. The fish caught during the surveys comprised 103 species (6,555 individuals) belonging to 42 families, some of which are economically important fishes (Figure 4). The Asian redbtail catfish (*Hemibagrus nemurus*) has been observed to be the most abundant species caught in the Barito River, especially in the flood plains comprising approximately 15-20 % of the total production (Rupawan & Rais, 2016; Rais & Wulandari, 2020), and is caught by the commonly used fishing gear in Barito River, *i.e.* traps with bait, and lines.

Fishing Practices

Barito River has been playing an essential role in the country's inland capture fisheries, providing the source of income and animal protein, and contributing significantly to the livelihoods of people in the River's surrounding areas, especially the small-scale fishers (Béné & Friend, 2009). Fishing operations in Barito River are conducted the whole year round, using small boats that are motorized or non-motorized such as canoes (Figure 5) and traditional fishing gears. In some areas that get water flowing from Barito River such as Hulu Sungai

Utara (HSU) that consists of 65 % flood plains, the people are able to use boats as their main mode of transportation while doing their daily activities (Dinas Perikanan HSU, 2015). Moreover, the activities in Barito River focused not only on capture fisheries but also on aquaculture in floating cages as well as post-harvest practices such as drying and salting the fish catch.

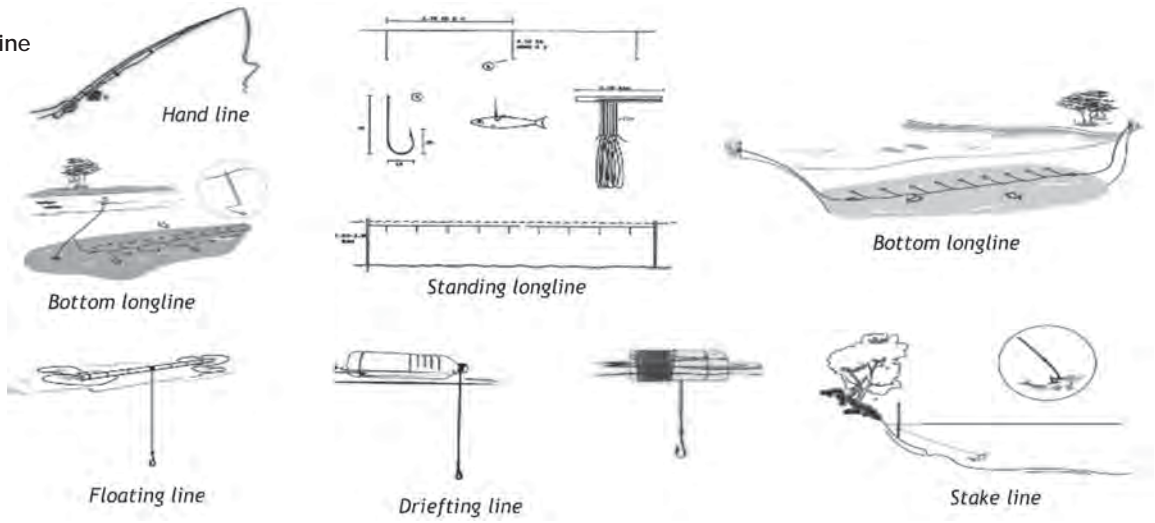
As observed during the survey, four groups of fishing gears (Figure 6) are being used by fishers in Barito River, *i.e.*, hook and longline, pot traps, trap nets, and gillnet (Rais *et al.*, 2018). Fishing gear is the main tool used to exploit the potentials of the fishery resources for food and animal protein needs, and to support the economy, especially that of the inland fishers' communities (Koeshendrajana & Oscar, 2001; Beard *et al.*, 2011).

Rupawan *et al.* (2016) reported that 31 types of fishing gears are being operated by fishers from the upstream to downstream zones of Barito River. Nonetheless, the fishing gear utilization and distribution had always been changing following the hydrology situation, the fish distribution pattern that is adequately related to the topography and deeps of Barito River (Bhattacharjee & Bhaskar, 2017). Fishing gear utilization seems to increase during the dry season when the water level is

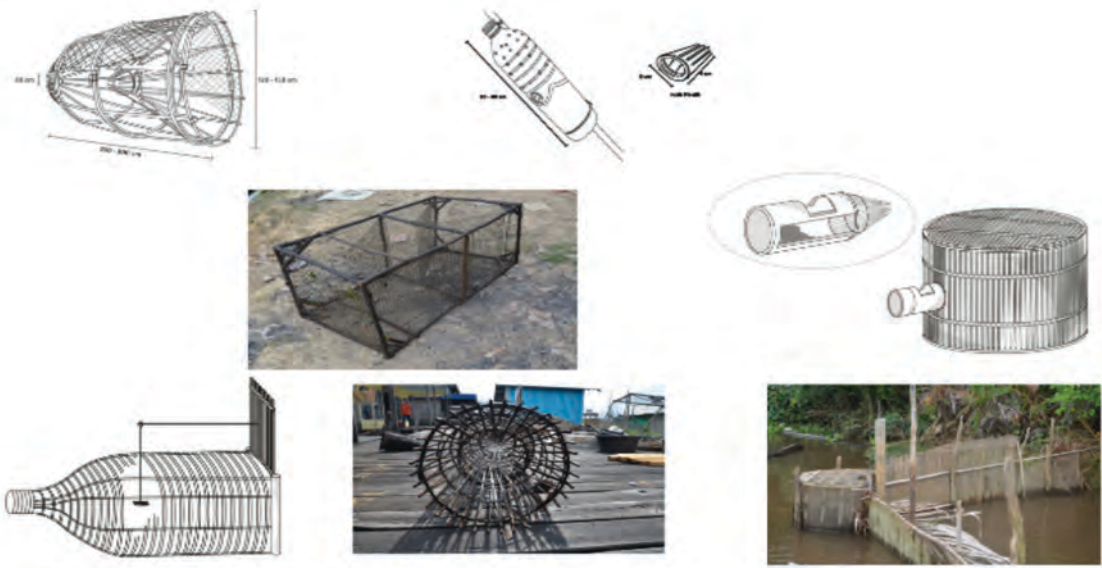


Figure 5. Small-scale boats, motorized or non-motorized used for fishing activities in Barito River

Hook & Longline



Pot Traps



Trap Nets

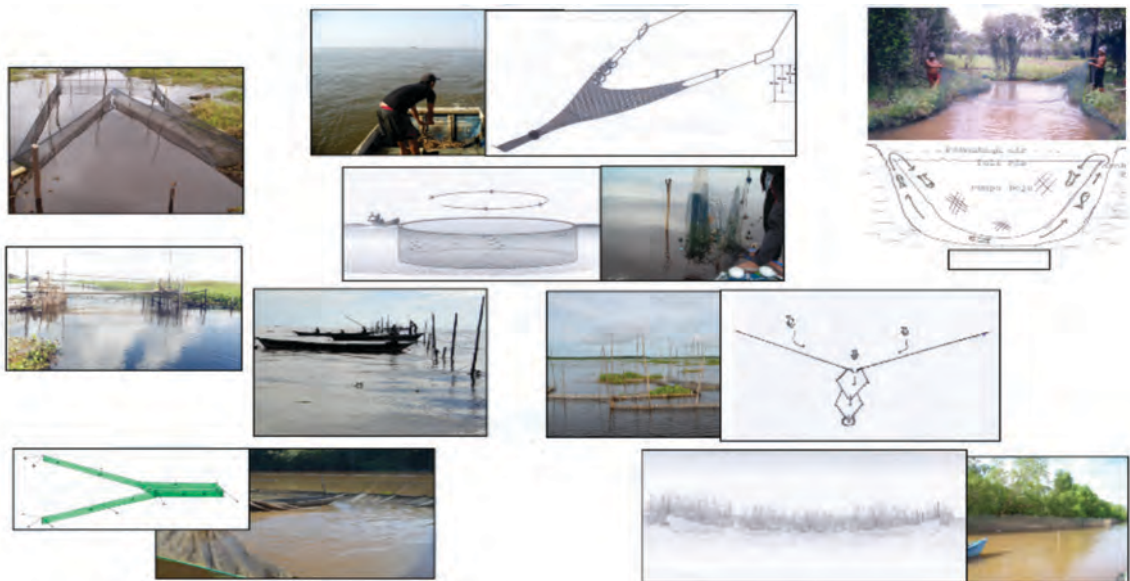


Figure 6. Groups of fishing gears operated in Barito River, Indonesia

Gill Nets

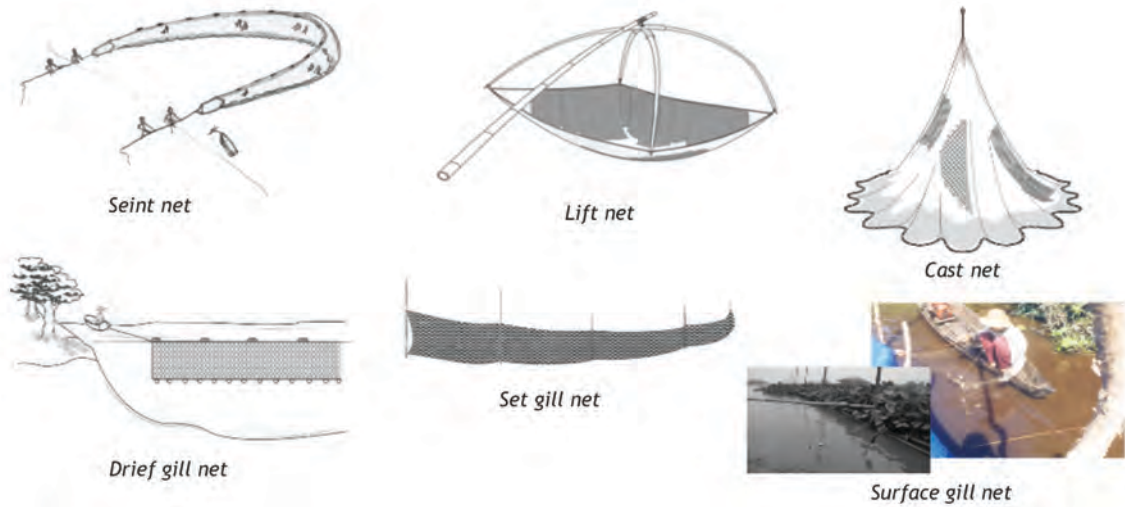


Figure 6. Groups of fishing gears operated in Barito River, Indonesia (Cont'd)

low, because the fish biomass will be flowed towards the areas with low water level or deep waters gathering into narrow areas or refuges, making the process of fishing operations efficient (Muthmainnah & Gaffar, 2017).

In some ecosystems however, particularly in flood plains with intensive fishing activities, fish production does not fluctuate following the conditions of the water level so that

production is steady for the whole year. The differences and variety of fishing gears used are the crucial factors that affect the amount of fish catch. The fishers become adaptive of the water fluctuations and target fish species by changing the type and selectivity of their fishing gears (Weiperth *et al.*, 2014).

Figure 7 shows the composition of fish caught by certain fishing gears operated in inland waters that are designed to

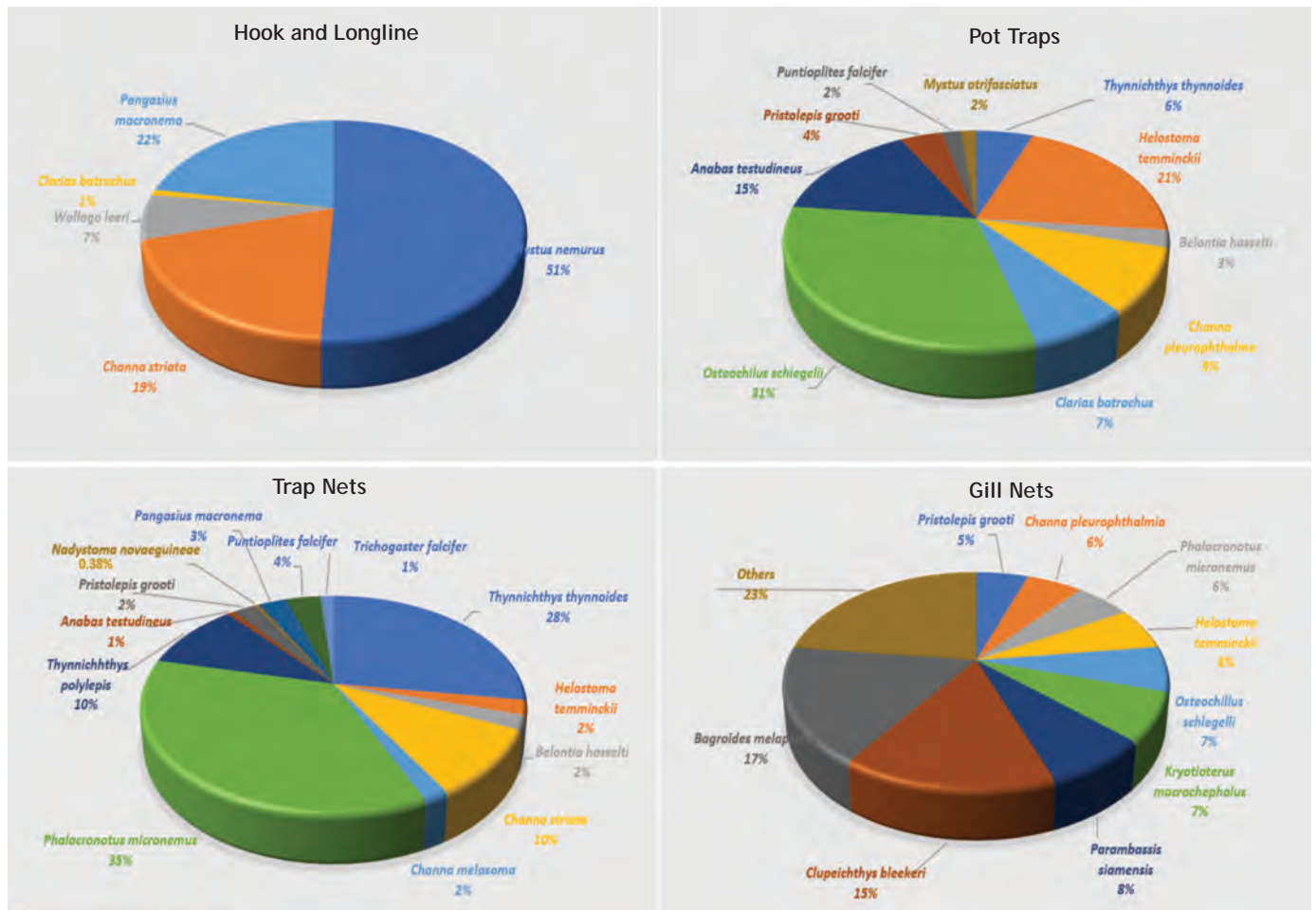


Figure 7. Composition of fish caught by types of fishing gears

be selective to the type of water ecosystem, *i.e.*, streams, flood plains or swamps, rivers, and bodies of steady waters (*e.g.* lakes, reservoirs). Some fishing gears, such as *jabak* and *lukah* that are classified as pot traps for catching specific target fishes, have also been modified to catch other specific fishes, *i.e.* baung or Asian red tail catfish (*Hemibagrus nemurus*).

Gill nets, such as *lalangit* (surface water gill net) had also been modified to be used for catching the labyrinth fish groups, *i.e.* climbing perch (*Anabas testudineus*), snakeskin gourami (*Trichopodus pectoralis*), and kissing gourami (*Helostoma temminckii*). Unfortunately, unselective, destructive, and illegal fishing methods, *e.g.* the use of poison and electricity, are still being practiced in Barito River.

Traditional Fishing Gear: Beje

A pond trap, “beje” (**Figure 8A**) is a pool constructed adjacent to rivers, inlets, and lakes, and meant to capture fish, and had been used by the “Dayak” tribe, the largest tribe in Central Kalimantan and South Kalimantan Provinces. The design of this fishing gear is only found in the Kalimantan River Basin. “Beje” is rectangular in shape and usually measures 10-30 m in length, 5-10 m in width, and 1.5-2.0 m deep (Rupawan, 2006).

In the rainy season (October-April), the “beje” becomes filled with water that flows in from the adjacent rivers, inlets, and lakes. Simultaneously, the fishes would move into the “beje” from the primordial waters. When dry season (May-September) comes and the water level recedes, then “beje” is separated from the adjacent waters, and where the fishes from the primordial waters are left in the pool. The fish can therefore be harvested from or bred in the “beje,” which the fishers had covered with branches and twigs to attract the fish to come into the pool and also to serve as shelters for the fish in the pool. Most “beje” are connected to small canals

that serve as conduit for the fish to go into the “beje pool.” The dimension of the canal is 1.0 m wide, 0.5 m deep, and 20-50 m long (**Figure 8B**). The “beje pool” and canal have soil embankments on one side to keep the water and prevent the fish from escaping into adjacent waters.

Harvesting fish from “beje” makes use of a specific kind of tool called “rempa net” (**Figure 8C**), which is rectangular in shape and made of polyethylene nylon with 1.5-2.5 cm mesh size in the stretch. Before harvesting fish from the “beje pool,” fishers remove the branches and twigs from the pool, and put the “rempa net” on the surface of the pool. The edges of the “rempa net” are fixed to the side slopes of the “beje pool” using pegs. Once the “rempa net” is fixed, fishers sink the center of “rempa net” towards the bottom of the “beje pool” by loading soil onto the net. The fishes in the “beje pool,” especially the blackfish (swamp fish), will rise to the surface between the edges of “rempa net” and the “beje pool” to breathe. Some of the fishes would jump into the “rempa net” and get easily caught by the fishers. Harvesting of fish from the “beje pool” usually takes 2-6 hours, depending on the fish abundance, and is done only once a year, which is during the dry season.

Fishers’ Income and Other Information

Data and information on operation time, total catch, and selectivity of fishing gears for one-year were obtained through the survey that interviewed 25 fishers in Barito River. In addition, the information on total gross income per fisher per month by fishing gears (**Table 1**) was also collected. Fish resources utilization in Barito River could be categorized as small-scale fisheries, and the average fisher’s family income of USD 4.27/day seems to be slightly below the Indonesian welfare standard (**Table 2**). Nevertheless, inland fishing in Barito River has in any way, been widely practiced and contributed meaningfully to people’s livelihoods, especially for the small-scale fishers.

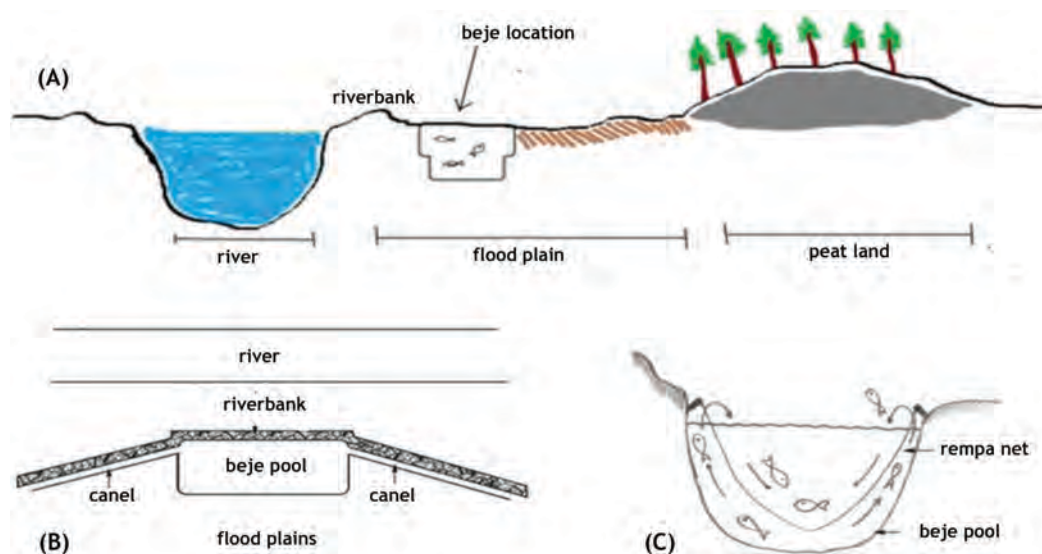


Figure 8. Proper location for constructing “beje” (adjacent to a river) (A), design of “beje” (B), and harvesting fish from the “beje” using “rempa” net (C)

Table 1. Operation time, catch and selectivity of fishing gears used in Barito River in one-year

No.	Fishing Gears	Fishers (person)	Operation time (hours)	Total Catch (kg)	Amount of Fishing Gear (unit)	Total Gross Income/Fisher/Month (USD)	Selectivity
1.	Hook & Longline	6	580	2,314.50	1,380	44.19	<i>Hemibagrus nemurus</i> ; <i>Pangasius macronema</i> ; <i>Channa striata</i>
2.	Pot Traps	7	792	6,488.20	319	88.50	<i>Osteochilus schiegellii</i> ; <i>Helostoma temminckii</i> ; <i>Anabas testudineus</i>
3.	Trap Nets	7	794	20,003.00	16	238.07	<i>Phalacrotonotus micronemus</i> ; <i>Hemibagrus nemurus</i> ; <i>Thynnichthys polylepis</i>
4.	Gill Nets	5	266	3,109.00	51	45.09	<i>Pangasius macronema</i> ; <i>Phalacrotonotus micronemus</i> ; <i>Thynnichthys polylepis</i> ; <i>Hemibagrus nemurus</i>

USD 1 = IDR 13,204 (December 2016)

Table 2. Total net income per fisher per day

Expenditure Cost (USD/month/fisher)	
Boat cost	4.88
Fishing gear cost	5.31
Fuel	10.34
Bait	2.12
Total	22.65
Net Income (USD/month/fisher) = Total gross income - total expenditure cost	
Hook and ines	89.65
Pot Traps	110.93
Trap Nets	215.41
Gill Nets	96.91
Total net income/fisher/day = USD 4.27	

USD 1 = IDR 13,204 (December 2016)

From the survey, it was found that the landless fishers mainly depend on fishing for their livelihoods, but are living below the poverty line. Meanwhile, fishers with agricultural lands and aquaculture ventures are much better in terms of their socio-economic conditions, which seems attainable when the fishers have alternative livelihoods and not dependent only in fishing.

In general, poverty leads the fishers to have limited access to utilize the fishery resources, especially that they do not have sufficient catching ability to produce fish because of insufficient capital to purchase the necessary fishing gear. In many cases, their catch is directly sold to middlemen who had lent them money before they could catch any fish. The respondents also suggested that the Government could support the fishers by providing them fishing gears and disseminating the necessary information on catch management, and to certain extent granting the fisheries capital or seed funds. A

sustainability system should also be developed and promoted around the fishing areas, to include alternative activities such as aquaculture and agriculture. This way, the fish stocks in the River could be allowed to recover and increase through natural recruitment or by culture-based fisheries, as pressure from fishing would be diminished.

Furthermore, the respondents also considered it necessary for the Government to empower the fishing communities, including the men and women members, to enable them to participate in the community activities as well as in the decision-making processes. The fishing communities could play the active role of advocating to the fishers the need to restore, conserve, protect, and co-manage the fishery resources. Moreover, it is also necessary to strengthen the governmental fisheries agencies, e.g. Fisheries Department, as they are tasked to take the leading role in improving the fishers' welfare, sustaining fishing community training centers where sustainable fishing practices could be promoted, and supporting community fisheries organizations.

Way Forward

From the results of the survey, it is clear that the socio-economic condition of fishers living in areas surrounding Barito River is not satisfactory. Most of the fishers appear to be less conscious of the modern capture fisheries techniques and practices as they continue to catch fish using traditional gear and craft. It is expected that the findings of this study would help the policymakers in taking the initiative to establish suitable fisheries management policies for the benefit of the fishers as well as that of the fishery resources in Barito River. The key messages about the sustainability of small-scale fisheries and the future of the fishers, as recommended by the respondents should be given attention by the Government agencies and the policy makers for the improvement of the socio-economic condition of the fishers and the sustainability of the fishery resources in Barito River.

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Boosting the Responsible Stewardship of a Precious Fishery Resource: the blue swimming crab in Angkaol Village, Kep Province, Cambodia

Jariya Sornkliang, Nopporn Manajit, and Isao Koya

The ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security Towards 2020 “Fish for the People 2020: Adaptation to a Changing Environment” in 2011 adopted the Resolution for SEAFDEC and ASEAN member countries to “optimize the use of inshore waters through resources enhancement programs such as promoting the installation of artificial reefs and structures, encouraging coordinated and effective planning for coastal fisheries management programs, undertaking environmental impact assessment studies, restocking of commercially-important fish species, as appropriate, and give priority to human resources development for the implementation of such programs.” In response therefore to such a provision, SEAFDEC/TD implemented in 2015-2019, the project “Promotion of Sustainable Fisheries Resources Enhancement Measures in Critical Habitats/Fishing Grounds in Southeast Asia” with funding support from the Japanese Trust Fund. The Project was aimed at gathering information for development of fisheries resources enhancement and habitat conservation measures in Southeast Asia; developing the capacity of human resources to implement the fisheries resources enhancement and habitat conservation measures; and promoting fisheries resources enhancement and habitat conservation measures suitable for respective countries in Southeast Asia. One of the major thrusts of the Project was to provide technical assistance and capacity building to target stakeholders on the rehabilitation of economically-important fishery resources as well as their habitats and fishing grounds. In this connection, one pilot activity carried out under the Project focused on the re-investigation of the management of the blue swimming crab resource in Angkaol Village in Kep Province of Cambodia, considering that more than 75 % of the local fishers in this Village depend mainly on blue swimming crab fisheries for their livelihood. This article describes the attempts made by SEAFDEC to assist the fishers of Angkaol Village not only in conserving their crab fishery resources but also in enhancing their capacity to sustainably manage such resources based on the EAFM concept.

Fisheries in Angkaol Village

Located in Damnak Chang'aeur District in Kep Province, Cambodia, Angkaol Village (**Figure 1**) has 189 fishers who are registered in the Angkaol Community Fisheries (CFi) in 2017, comprising 133 collapsible crab trap fishers, 16 crab gill netters, 34 fish gill netters, and 6 squid jiggers. Being a beach area, the Village also serves as a landing place for fishers upon returning from their fishing operations in the sea (**Figure 2**).



Figure 1. Location map of Angkaol Village in Kep Province, Cambodia (Source: Google maps)



Figure 2. Location of the pilot project site in Angkaol Village, Kep Province of Cambodia

In July 2018, a team from SEAFDEC/TD conducted the baseline fisheries survey in the Angkaol Village to gather the demographic information from the fishing households, and also on the gender's roles in fisheries and relevant data on blue swimming crab fisheries. From the total number of fishers in the Village, 60 fishers (11.7 % female and 88.3 % male) were engaged as respondents for the survey. The average age of the respondents was 35 years old and their ages ranged from 20 to 60 years old. In terms of educational level, 33.3 % did not attend school, 50.0 % finished elementary school, 15.0 % finished junior high school, and 1.7 % had finished their bachelor's degrees.

The major occupation of the village household is fishing followed by agriculture. Each household has on the average five family members, and earns an average monthly income of

around 357 US\$, of which their average monthly expenditures could amount to about 143US\$.

Gender roles in the fisheries of Angkaol Village

The reproductive and productive roles of women, men, girls, and boys were also investigated during the baseline survey in Angkaol Village, the results of which are shown in **Figure 3**. Reproductive roles encompass not only child bearing and child rearing responsibilities, but also include doing domestic tasks and household chores. On the other hand, productive roles are the activities carried out by women and men in order to produce goods and services either for sale, exchange, or to meet the subsistent needs of their families.

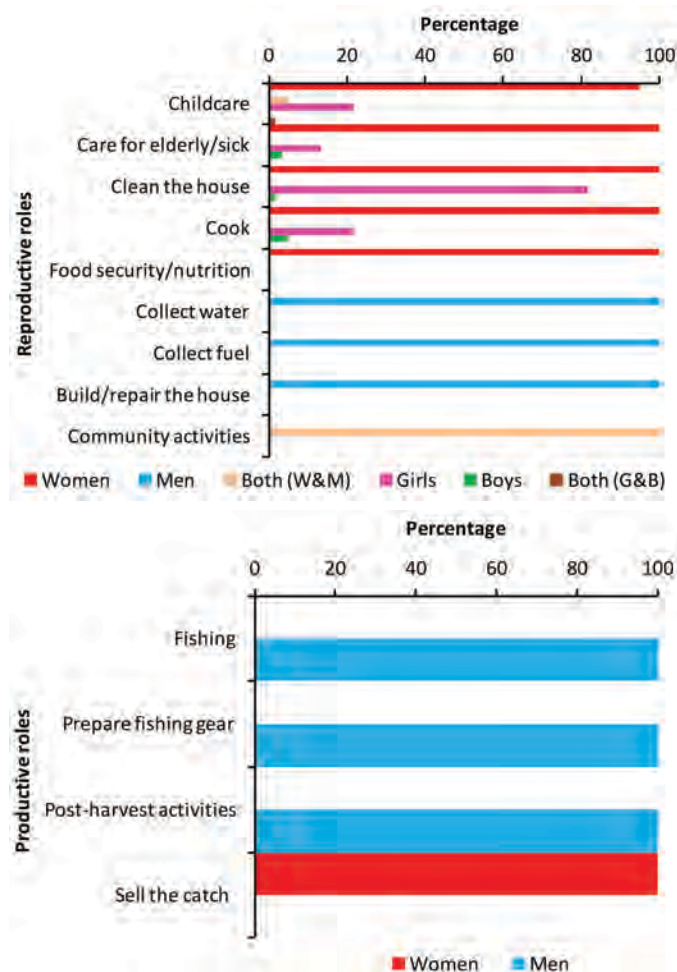


Figure 3. Reproductive (top) and productive (bottom) roles of women and men in Angkaol Village, Kep Province, Cambodia

For the reproductive roles, women, girls, and boys work for the household daily chores that include childcare, care for the elderly and the sick family members, cooking, cleaning, and maintaining food security and nutrition (e.g. home gardening, livestock raising, gathering shells and bivalves). While men usually do the heavy jobs such as water collection, fuel collection or energy production, and building/repairing the family’s house. Even though a few women and men care for children together, both women and men participate in community events such as

weddings and funerals, among others.

For productive roles, only men are involved in fishing at sea, fishing gear preparation, and post-harvest activities (remove blue swimming crab from the net at sea), while women peel and/or sell the fishers’ catch of blue swimming crab. Looking at the gender roles using the gender lens in Angkaol Village, women focused on household chores while men were mainly engaged in fishing activities. Women did not recognize themselves as fishers and were not confident to provide the real information with respect to their fisheries-related activities. However, the Project considered it necessary to also record the productive roles of women in the fishing communities so that the women would also be given the chance to participate in the capacity building activities which is one of the Project’s thrusts. Thus, the Project Team made sure that certain existing barriers were eliminated during the survey and the meaningful participation of women in fisheries is recognized as such role also contributes to food security and poverty reduction in the fishing communities.

Blue swimming crab fisheries in Angkaol Village

In Angkaol Village, the main aquatic species caught by fishers the whole year, is the blue swimming crab (*Portunus pelagicus*) using collapsible crab traps and crab gill nets (Figure 4). This makes the blue swimming crab the most economically important fishery resource of the Village. To catch the blue swimming crab, fishers use fishing boats that are made of wood with an average length of 11.0 m and equipped with out-board engines (Figure 5).



Figure 4. Crab traps and crab gill nets for catching the blue swimming crab



Figure 5. Typical gill net fishing boat in Angkaol Village used for catching the blue swimming crab

Table 1. Blue swimming crab fishery in Angkaol Village, Kep Province, Cambodia

	Crab trap	Crab gill net
No (traps) or length (m) of fishing gear	200-5,000 traps	250-2,500 m
Average no. or length (m) of fishing gear	1,500 traps	1,500 m
Fishing season (months)	January-December	January-December
No. of fishing days per month	10-27	15-25
No. of fishing hours per day	6-14	8-10
No. of hauls per fishing trip	1-2	1-2
Ave. catch (kg) per fishing trip	16	16
Average cost (US\$) per fishing trip	27.5	28.0

The specific fishing grounds for the blue swimming crab in Angkaol Village are located around Pou Island, Rabbit Island, and Ach Ses Island, where fishing is done all year round with the use of collapsible crab traps (by 85 % of fishers) and crab gill nets (by 25 % of fishers). The average catch of the blue swimming crab per trip from both fishing gear is 16.0 kg at an average fishing cost of USD 27.5 (Table 1).

Issues and constraints

Although a quarter of the respondents did not mention any problems related to their fishing activities, the majority

Box 1. Towards the sustainable management of blue swimming crab fisheries in Angkaol Village

- Establishment of zoning areas for small- and large-scale fishing gears (collapsible crab trap, crab gill net, trawlers)
- Elimination of illegal fishing gears such as the elongated collapsible crab trap as it catches all sizes (Figure 6)
- Conduct of more frequent patrol activities, especially at night to monitor illegal fishing activities
- Preservation of habitat areas, e.g. sea grass beds
- Establishment of protected areas for blue swimming crabs
- Revival of crab banking



Figure 6. Elongated collapsible crab trap considered illegal fishing gear in Angkaol Village because it catches all sizes of crabs

indicated that they experienced several issues and constraints including severe weather conditions (e.g. heavy rains, storms), lost fishing gear (stolen), destroyed fishing gear by trawls, and low amount of catch. In this regard, suggestions were made during the series of village consultations, for the sustainable management of blue swimming crab fisheries in Angkaol Village, which necessitated action through the implementation of the Project (Box 1) by SEAFDEC/TD.

Interventions of the Project for the sustainability of blue swimming crab resources in Angkaol Village

During 2017-2019, the Project through SEAFDEC/TD in collaboration with the Fisheries Administration (FiA) of Cambodia, provided technical assistance and supported the capacity building activities for the Angkaol CFi, particularly to revive the operation of its crab bank system as means of improving the livelihood of fishers and enhancing the blue swimming crab resources. This was a response to the request made by FiA Cambodia for SEAFDEC to assist the Angkaol CFi in reviving its crab bank operations (SEAFDEC, 2020).

Thus, the Project Team from SEAFDEC/TD organized series of meetings with FiA officers and the Community Fisheries (CFi) members in 2017, to discuss the ways and means of reviving the crab bank system in Angkaol Village (Figure 7). The Village used to operate a crab bank in 2015 but this activity did not succeed due to poor management and lack of commitment among the members of the crab bank group. Upon agreeing that the members of the CFi would voluntarily



Figure 7. Meeting among Project Team from SEAFDEC/TD, FiA officers, and CFi members agreed on the revival of the crab bank system in Angkaol Village

Box 2. Agreed scheme for reviving crab bank system at Angkaol Village

- Each CFI member would provide gravid crabs (at least one (1) or two (2) per month) to Mr. Meas Va, former leader of the crab bank group, who volunteered to take care of the crab bank during the initial stage
- Transparency in the management of the crab bank should be maintained by recording the persons donating the gravid crabs and the number of crabs received, for the information of anyone who wants to check the status of the crab bank at any time
- After the eggs are released and the spent crab spawners are sold, the money from the sale should be properly recorded indicating how much money was earned and how much money was spent for the crab bank management
- Traders would be encouraged to participate in the crab bank by donating the gravid female crabs that they have in their possession

donate gravid female crabs in the crab bank until the eggs are hatched and the zoea crabs released to the sea grass beds at the Angkaol CFI conservation zone, the meeting came up with a management scheme (SEAFDEC, 2020) for its revived crab bank system (**Box 2**).

Crab bank is an activity aimed at enhancing the stocks of crabs by keeping the gravid crabs alive in cages installed at sea or in tank at shore with oxygen until the spawners release their eggs. After spawning, the spent crabs are sold for consumption or for processing while the zoea crabs are released to the sea (DOF, 2011). Realizing the potential that crab banks offer to enhance the blue swimming crab resources, the FiA first began to promote the crab bank system in Cambodia in 2007. Since then, crab banks have been established in several CFIs with support from international organizations (Sopanha, *et al.*, 2012; RFLP, 2013), although the crab bank at Angkaol Village did not progress due to management constraints.

Revival of crab bank system in Angkaol Village

Through the Project, a crab bank structure that includes a hatchery and net cage for the gravid spawners (**Box 3**) was constructed in November 2018, in a sea grass area located close to the fish landing site and at a water depth of approximately 1.0 m during low-tide (**Figure 8**). Electricity is supplied through a solar cell panel and also from a household electric supply when there is not enough power from the solar cell. In the revived crab bank structure in Angkaol Village, the gravid crabs are separated based on the color of eggs that indicates the development stage of crab eggs.

Since then, gravid female crabs have been donated by members of the Angkaol CFI in the crab bank. All donations are reported on the whiteboard, while the monthly record indicating the fisher's name and number of gravid crabs donated, is updated regularly and kept by the CFI Leader in a logbook.



Figure 8. Crab bank structure in Angkaol Village (*left*), comprising a hatchery (*upper-below*) and net cage (*lower-below*)



Box 3. The crab bank structure in Angkaol Village comprises a hatchery and net cage for stocking of gravid crab spawners

1. Hatchery comprises 10 aerated plastic tanks, are used for stocking gravid crabs with grey and black eggs (**Figure 9**) at a stocking rate of one gravid crab per tank. These gravid crabs usually take one or three days to release their eggs, thus, saving on electricity (DOF, 2011). Powered by an electric supply, the tanks are aerated to keep the gravid crabs alive while waiting for the eggs to be released and subsequently hatched then released to the sea.
2. The net cage installed below the hatchery is two-thirds submerged in the water, and is meant for gravid crabs with yellow-orange and brown eggs (**Figure 9**). These gravid crabs usually take more than three days to release the eggs (DOF, 2011), and once the eggs are hatched these could be dispersed naturally to the sea. Upon seeing that the gravid crabs in the cage were eaten from outside the cage by predators (*e.g.* "old woman" octopus *Cistopus indicus* Féruillac & d'Orbigny, 1835), the fishers agreed to put the gravid crabs in covered plastic baskets (**Figure 10**) and placed in the net cage.



Figure 9. Gravid female blue swimming crabs with grey eggs (above) and orange eggs (below) for hatching at the crab bank in Angkaol Village



Figure 10. Covered plastic baskets for stocking of gravid crabs and placed inside the net cage to prevent predation mainly by octopus

Shown in **Figure 11** is the list of seven fishers who donated in February 2019 and 13 fishers in May 2019, indicating increased interest and strengthened the cooperation among the fishers in Angkaol Village in sustaining the crab bank. This has improved the management of the crab bank system which the CFI members agreed to sustain to enhance the crab resources in their Village.

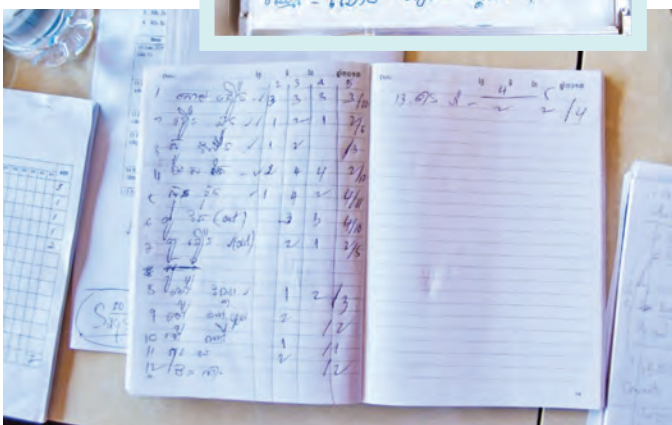
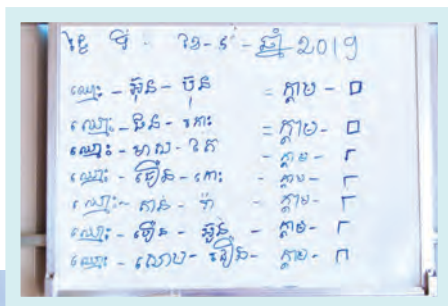


Figure 11. Report of daily donations of gravid crabs indicating the fisher's name and the number of gravid crabs donated on whiteboard (inset) and monthly recording of gravid crab donations in logbook for transparency of the management of the crab bank system in Angkaol Village

The members of the Angkaol CFI in one of their meetings established their own regulations (**Box 4**) for the successful operation of the crab bank. Moreover, the Angkaol CFI also promotes the conservation of blue swimming crabs by enforcing the regulation that prohibits the catching, selling, and buying of undersized crabs or more than 20 pieces/kg.

Box 4. Regulations for the successful operation of the crab bank at Angkaol Village

- Zoea stage of crabs should be released to the Angkaol CFI conservation zone
- All records of the crab bank should be transparent including:
 - names of fishers and number gravid female crab donated
 - income from selling spawned crabs
 - expenditures
- Income from selling spawned crabs should be allocated to the following:
 - 10 % for savings of the crab bank
 - 20 % for crab bank committee
 - 70 % for operation costs (revolving money) of the crab bank
- Funds should be spent only for the development and management of the crab bank
- Revenues received from other sources should be kept in the crab bank account
- Promote the conservation of blue swimming crabs and prohibit the catching, selling, and buying of undersized crabs which are more than 20 pieces/kg

Raising awareness on the conservation and management of fishery resources

To make the Project activities known to the whole Village as well as its surrounding areas, and to enhance the awareness of fishers and other stakeholders on the need to conserve and sustainably manage the fishery resources, signboards indicating the conservation and management activities were put up in strategic areas in the Village. The signboards that contain the information on the conservation zone as well as that of the crab bank system, were so designed that it would be easy for the stakeholders to notice and the information

Box 5. Signboards with the information on conservation zone and crab bank system

- Signboard for conservation area (Figure 12)
 - Any fishing activities are prohibited in the conservation area of the CFI
 - Prohibited fishing includes the use of modern fishing gear, new fishing gear, new fishing method or other fishing gear which are not listed in the Regulation issued by MAFF and destructive fishing practices which may affect to fishery resources or fisheries ecology system
 - It is prohibited to catch, buy, sell, stock, transport the small or eggs of fish and aquatic animals
 - It is prohibited to catch, buy, sell the blue swimming gravid crabs
 - It is prohibited to fish or do any activities that affect the sea grass beds and coral reefs
- Signboard for crab bank system (Figure 13)
 - Please donate gravid crab
 - We need your cooperation: No catch, No sell, No buy under sized crabs (>20 pieces/kg)



Figure 12. Signboard for the conservation area

are written in the Khmer language (Box 5). The signboard for the conservation area bears the name: Angkaol Fisheries Community Conservation Area, includes the list of regulations on fishing in Angkaol CFI (ref: Agreement of Angkaol Fisheries Community, 2012), and also the motto: “Conserve Marine Resources for the Prosperous Future.” On the other hand, the signboard for the crab bank dubbed as Enhancement of the Sustainable Management of the Blue Swimming Crab Fisheries in Angkaol Community Fisheries, Angkaol Village, Angkaol Commune, Domnak Chang Eur District, Kep Pprovince, includes the Key Message: “together donate one gravid crab, increase by the thousands the crabs in the sea.”

Capacity building for relevant stakeholders in Angkaol Village



Figure 13. Signboard for the crab bank system

The Angkaol CFI has established a conservation area that covers an area of approximately 100 ha (1.0 km²) which had been declared by the local government authorities as a protected area for fishery habitat restoration of fisheries resources including the blue swimming crabs, sea grass beds and others. All fishing activities are prohibited in the conservation area. Angkaol CFI had installed buoys to demarcate the conservation area and make it easily identifiable from a distance.

Installation of buoys for the conservation area

The Project also provided technical support by training the members of the Angkaol CFI on the fabrication of the buoys (Figure 14), as well as the materials used for the 12



Figure 14. Clockwise from top left: Angkaol CFI conservation area (green area), training to construct buoys, installation of buoys to the conservation area, and buoy installed in Angkaol CFI conservation area in Kep Province, Cambodia

conservation buoys made of 100 liters capacity plastic drums filled with mixed cement and painted in white so that these could be easily seen from the sea. The buoys were fixed in the sea by sinkers made of 35×40×30 cm cement blocks that approximately weigh about 100 kg/block.

Study trip to Thailand

A study trip to Thailand was organized by the Project on 6-12 October 2019 for three FiA officers, two Fisheries Administration Cantonment (FiAC) in Kep Province, and two CFi members. The participants of the study trip visited five fishing villages in Thailand, namely: 1) Tong Tom Yai Village in Chumphon Province, 2) Phru Jood Village in Trang Province, 3) Lampho Community in Chai Ya District, Surat Thani Province, 4) Pak Nam Pran Village in Prachuap Khiri Khan Province, and 5) Lam Phak Bia Crab Bank Group in Phetchaburi Province. The purpose of the study trip (Figure 15) was to enhance the knowledge of the Angkaol CFi members on the management measures for the conservation of the blue swimming crab resource as well as exchange views and experiences with the fishers' groups in Thailand on the sustainability of the crab bank system.



Figure 15. Representatives from Angkaol Village on study trip to Thailand organized by the Project to learn on resource management of blue swimming crab and crab bank system

Through this study trip, the fishers from Angkaol Village were able to directly obtain information on the measures for blue swimming crab conservation and management system in Thailand. Such management measures would be taken-up and applied in Kep Province for the sustainable utilization of the blue swimming crab resources in the future. The fishers also learned that the Crab Bank System in Thailand serves not only as crab resource enhancement but also as means of generating alternative job for the fishing communities. The results of the study trip had confirmed that the fisheries of blue swimming crab is important for the livelihood of villagers at Kep Province especially in Angkaol Village because it is the main livelihood that can provide an income US\$ 357 per month.

Conclusion and Recommendations

Members of the crab bank group in Angkaol Village have the obligation to voluntarily provide gravid blue swimming crabs. In case there would be sufficient numbers of gravid blue swimming crabs donated, these could be sold and the proceeds should be fully accounted following the regulations shown in **Box 6**.

Finally, the lessons that had been learned from the implementation of the activity at Angkaol Village in Kep Province, Cambodia are shown in **Box 7**.

Box 6. Financial regulations for the crab bank system

- Budget management should adopt the proper accounting procedures
- Revenues received from other sources must be kept in a crab bank account
- Every expenditures and relevant transactions must have invoices and properly accounted for
- Funds should be disbursed only for the purpose of management, conservation, and development of the crab bank
- Crab bank committee shall receive 20 % of the proceeds from the sale of the crabs
- 10 % of the proceeds from sale of the crabs should be saved
- Operation cost for crab bank should be 70 % of the proceeds from the sale of the crabs

Box 7. Lessons learned from the implementation of the activity to revive the crab bank system in Angkaol Village

- Collection of qualitative and quantitative data, such as those on the biology of particular fishery resource in focus and the socioeconomics of concerned communities, is important throughout the implementation of any fishery resources enhancement effort, as precautionary approach to protect and conserve the resources, while the information collected would serve as baseline data for planning any project activity, and as indicators for monitoring and evaluation of the activity.
- Sustainability of the project activity is essential to prove the success of any fishery resources enhancement efforts, therefore it is necessary to engage the villagers in the planning and implementation of any activity, as partnership is very important to ensure that the project activities could be sustained.
- It is necessary to minimize the impact of any activity on the fishery resources while maintaining the livelihoods of fishers, which should be the goal of any fishery resources enhancement and management efforts. Hence strengthening the capacities and awareness of local officers, fishers, villagers (women and men, elderly, and youth) should be part and parcel of any resources enhancement efforts, as their participation and willingness to be engaged with the fishery resources enhancement and management efforts would boost the sustainability of the efforts.

Way Forward

The achievements of the Project would support the Policy Recommendations and Strategic Plan of Action for the Implementation of Fisheries Resources Enhancement Activities in the Southeast Asia Region, which were adopted by the ASEAN Member States in 2015.

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CALENDAR OF EVENTS

Date	Venue	Event	Organizer(s)
2020			
3 February	Bangkok, Thailand	Preparatory Meeting for the next JAIF Project on Tropical Anguillid Eel Resources in Southeast Asia	SEAFDEC Secretariat
5-7 February	Hai Phong, Viet Nam	3 rd Regional Scientific and Technical Committee Meeting for SEAFDEC/UNEP/GEF Project on Fisheries <i>Refugia</i>	SEAFDEC/TD
10-14 February	Bali, Indonesia	28 th Session of the Asia and Pacific Commission on Agricultural Statistics	FAO/RAP
10-15 February	Samut Prakan, Thailand	Practical Workshop on Stock and Risk Assessments of Longtail tuna and Kawakawa in the Southeast Asian waters	SEAFDEC Secretariat
18-20 February	Bali Indonesia	Capacity Building on Global Marine Debris Monitoring and Modeling: Supports Protection of the Marine Environment	APEC
9-13 March	BFS, Rizal, Philippines	Training Course on Tilapia Hatchery & Grow-out Operations	SEAFDEC/AOD
29 April	Teleconference	FAO/APRACA Project Meeting on Capacity Development in Micro-finance, Credit and Insurance in Small-scale Fisheries	FAO/APRACA
19 May	Teleconference	52 nd Meeting of the SEAFDEC Council: Teleconference Session	SEAFDEC
21 May	Virtual Meeting	12 th International Forum on Illegal, Unreported and Unregulated (IUU) Fishing	Chatham House
27-28 May	Virtual Meeting	Technical Workshop on the Development of an ASEAN General Fisheries Policy (AGFP) Feasibility Study	ASEAN & DOF Thailand
16 June	Virtual Meeting	The Ad-hoc Meeting of the Project Steering Committee for the SEAFDEC/UN Environment/GEF Project on Establishment and Operation of a Regional System of Fisheries Refugia in the South China Sea and Gulf of Thailand	SEAFDEC/UN Environment/GEF Project
22 June	Virtual Meeting	10 th Meeting of the ASEAN Shrimp Alliance (ASA)	ASEAN & DOF Thailand
25-27 June	Virtual Meeting	28 th Meeting of the ASEAN Sectoral Working Group on Fisheries	ASEAN Secretariat
July (Tentative)	Virtual Meeting	Inter-Departmental Workshop on Preparation for Publication Southeast Asian State of Fisheries and Aquaculture (SEASOFIA) 2022	SEAFDEC Secretariat
3 August	Virtual Meeting	Special Senior Officials' Meeting of the 41 st Meeting of the ASEAN Ministers on Agriculture and Forestry	ASEAN Secretariat
17 Aug-7 Sep*	TMS, Iloilo, Philippines	Training Course on Mangrove Crab Hatchery Operations	SEAFDEC/AOD
2 Sep-8 October	TMS, Iloilo, Philippines	Training Course on Marine Fish Hatchery Operations	SEAFDEC/AOD
14-16 September (Tentative)	Kuala Lumpur, Malaysia	Core Expert Meeting for Sustainable Utilization and Management of Sharks and Rays in the Southeast Asian Region	SEAFDEC/MFRDMD
21-30 September*	TMS, Iloilo, Philippines	Training Course on Mangrove Crab Nursery & Grow-out Operations	SEAFDEC/AOD
September (Tentative)	Online	Training Course on AquaNutrition Online	SEAFDEC/AOD
Sep/Oct (Tentative)	Kuala Lumpur, Malaysia	Core Expert Meeting on Pelagic Fish Resources in the Southeast Asian Region	SEAFDEC/MFRDMD
Sep/Oct (Tentative)	Kuala Lumpur, Malaysia	6 th Meeting of the Scientific Working Group (SWG) on Neritic Tuna Stock Assessment in the Southeast Asian Waters	SEAFDEC/MFRDMD
5-13 October	TMS, Iloilo, Philippines	Training Course on Sandfish (<i>Holothuria scabra</i>) Seed Production, Nursery and Management	SEAFDEC/AOD
6-9 October (Tentative)	Singapore	Inception Workshop for the Project on Enhancing Food Safety and Competitiveness of Seafood Products	SEAFDEC/MFRD
October (Tentative)	TMS, Iloilo, Philippines	Training Course on Fish Health Management	SEAFDEC/AOD
October (Tentative)	Belitung, Indonesia (To be confirmed)	21 st Meeting of SEAFDEC Information Staff Program (ISP)	SEAFDEC
10-12 November (Tentative)	Iloilo, Philippines	43 rd Meeting of the Program Committee Meeting (PCM)	SEAFDEC/AOD
13-14 November (Tentative)	Iloilo, Philippines	23 rd Meeting of the Fisheries Consultative Group of the ASEAN-SEAFDEC Strategic Partnership (FCG/ASSP)	SEAFDEC Secretariat
15 November (Tentative)	Iloilo, Philippines	SEAFDEC Department Chiefs' Meeting	SEAFDEC

* accepting applications, but the training is subject to COVID-19 situation

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. SEAFDEC currently comprises 11 Member Countries: Brunei Darussalam, Cambodia, Indonesia, Japan, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam.

Vision

Sustainable management and development of fisheries and aquaculture to contribute to food security, poverty alleviation and livelihood of people in the Southeast Asian region

Mission

To promote and facilitate concerted actions among the Member Countries to ensure the sustainability of fisheries and aquaculture in Southeast Asia through:

- i. Research and development in fisheries, aquaculture, post-harvest, processing, and marketing of fish and fisheries products, socio-economy and ecosystem to provide reliable scientific data and information.
- ii. Formulation and provision of policy guidelines based on the available scientific data and information, local knowledge, regional consultations and prevailing international measures.
- iii. Technology transfer and capacity building to enhance the capacity of Member Countries in the application of technologies, and implementation of fisheries policies and management tools for the sustainable utilization of fishery resources and aquaculture.
- iv. Monitoring and evaluation of the implementation of the regional fisheries policies and management frameworks adopted under the ASEAN-SEAFDEC collaborative mechanism, and the emerging international fisheries-related issues including their impacts on fisheries, food security and socio-economics of the region.



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The third prize winner, *Risa Nakahara*, from the national drawing contest in Japan

National Drawing Contests were organized in all ASEAN-SEAFDEC Member Countries as part of the preparatory process for the ASEAN-SEAFDEC Conference 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.