FISH for the PEOPLE

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A Score of Ongoing Commitment for Sustainable Fisheries in Southeast Asia: the Japanese Trust Fund at SEAFDEC

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Editorial

Since the establishment of the Southeast Asian Fisheries Development Center (SEAFDEC) in 1967, the Government of Japan has provided SEAFDEC with funds to support the operation of the Center. At the outset of the establishment of the Training Department (TD) and the Marine Fisheries Research Department (MFRD) in 1968, the Government of Japan provided SEAFDEC with funds that were necessary for the launching of these Departments, including the purchase of training and research vessels, shore instruments and equipment. Similar types of support, as applicable, were also provided by the Government of Japan to the other SEAFDEC Departments during their establishments.

The contributions of the Government of Japan to SEAFDEC were originally channeled through its Ministry of Foreign Affairs (MOFA), the Overseas Technical Cooperation Agency (OTCA) and the Japan International Cooperation Agency (JICA). Such arrangements went on until the policy of the Government of Japan on its Official Development Assistance (ODA) was revised. Thus, starting in 1998 or about 20 years ago, the Japanese Trust Fund (JTF) through the Fisheries Agency of Japan became the primary channel of the financial assistance of the Government of Japan to SEAFDEC.

With such sustained funding support, SEAFDEC has been able to continue implementing regional projects for the promotion of sustainable fisheries development in Southeast Asia. Six phases that span from 1998 to 2019 with more than 60 projects have been implemented by SEAFDEC under the JTF, *i.e.* JTF-1 to JTF-6. Through these JTF projects, a number of technologies, guidelines and policy recommendations had been amassed, and disseminated to and adopted by the Southeast Asian countries for the betterment of their respective fisheries sector.

To commemorate the 20 years of continued support of the JTF to SEAFDEC, this Special Issue of Fish for the People depicts the achievements of the JTF-6 projects considering that those advances attained under the previous JTF phases had already been published in the earlier issues of the Special Publication. With this issue, SEAFDEC wishes to express the sincerest gratitude to the Government of Japan for its generous support accorded to SEAFDEC through the years, as well as the strong commitment to continue the efforts of revolutionizing the Southeast Asian fisheries towards sustainability using the JTF, as SEAFDEC continues to sail the region beyond its 50th Anniversary in December 2017.

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

Towards Sustainable Fisheries Development in Southeast Asia: the Twenty-Year Japanese Trust Fund Saga in SEAFDEC

Kaoru Ishii, Tetsuya Kawashima, and *Virgilia T. Sulit*

After the establishment of the Southeast Asian Fisheries Development Center (SEAFDEC) in 1967, the Government of Japan through its Ministry of Foreign Affairs provided funds for the operations of SEAFDEC and the Departments in accordance with the Agreement Establishing SEAFDEC until 2006. In 1998 and in addition to these funds, the Fisheries Agency of Japan started to provide SEAFDEC with the Japanese Trust Fund (JTF). The continued financial assistance from the Government of Japan through the JTF enabled SEAFDEC to pursue the implementation of its regional projects and activities in Southeast Asia.

The Japanese Trust Fund at SEAFDEC

To date, six phases of SEAFDEC projects funded through the Japanese Trust Fund (JTF) had been implemented in the Southeast Asian region starting in 1998 and extending until 2019 (**Box 1**). Throughout this 20-year journey of the JTF at SEAFDEC, a number of activities carried out by the SEAFDEC Secretariat and Departments (SEAFDEC, 2008) had been completed resulting in developed fisheries and aquaculture technologies and transferred to the Southeast Asian countries through enhanced capacity building, as well as policy recommendations and guidelines that were used by the countries to revise their respective laws and regulations for the sustainable development of their fisheries. Under the JTF, the project activities carried out in the region had been formulated taking into consideration the global Code of Conduct for Responsible Fisheries (CCRF) which was regionalized by SEAFDEC starting in 1998 to facilitate its adoption by the Southeast Asian countries, as well as the series of two Resolutions and Plans of Action for Sustainable Fisheries in the ASEAN Region (SEAFDEC, 2001; SEAFDEC, 2011) that were adopted during the ***ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security in the New Millennium: "Fish for the People"*** in November 2001 and the subsequent ***ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security Towards 2020 "Fish for the People 2020: Adaptation to a Changing Environment"*** in June 2011.

Specifically, the implementation of the projects and activities under the JTF-6 (**Box 1**) had been enhanced following the Joint ASEAN-SEAFDEC Declaration which was adopted during the ***High-level Consultation on Regional Cooperation in Sustainable Fisheries Development Towards the ASEAN Economic Community: Combating IUU Fishing and Enhancing the Competitiveness of ASEAN Fish and Fishery Products*** conducted in August 2016 (SEAFDEC, 2016). The most significant advances and achievements attained by SEAFDEC through the implementation of the numerous projects funded by the JTF are summarized in this article.

Regionalization and Promotion of the Code of Conduct for Responsible Fisheries

The SEAFDEC Strategic Plans adopted by the SEAFDEC Council in 1997 on the occasion of the 30th Anniversary of SEAFDEC, included provisions directed towards the sustainable utilization of the region's fishery resources. The Strategic Plans also outlined policy issues that include the promotion of responsible fisheries in the region taking into consideration the global CCRF which was adopted during the FAO Conference in 1995 (FAO, 1995). Since the global CCRF had not considered some areas related to fisheries development and management applicable in the Southeast Asian region, the SEAFDEC Council in 1998 endorsed the implementation of the proposed Regionalization of the CCRF to be spearheaded by SEAFDEC with funding support from the Government of Japan through the JTF. Regionalization of the CCRF was aimed at clarifying the requirements of the CCRF; identifying and prioritizing the required actions; identifying the issues that require special consideration from the regional point of view; formulating regional policies that would help the Southeast Asian countries in implementing the global CCRF; and facilitating the formulation and implementation by the Southeast Asian countries of national codes of practices for responsible fishing operations, fisheries management, aquaculture, and fisheries post-harvest and trade (Ekmaharaj, 2007).

The outputs of the JTF-funded Regionalization of the CCRF (RCCRF) were published as a series of "Regional Guidelines for Responsible Fisheries in Southeast Asia," namely: "Responsible Fishing Operations" (SEAFDEC, 2000); "Responsible Fisheries Management" (SEAFDEC, 2003), "Responsible Post-harvest Practices and Trade" (SEAFDEC, 2005); "Responsible Aquaculture" (SEAFDEC, 2001a (1st Ed); SEAFDEC, 2005a (2nd Ed)); and "Supplementary Guidelines on Co-management Using Group User Rights, Fishery Statistics, Indicators and Fisheries *Refugia*" (SEAFDEC, 2006). The Regional Guidelines had since then been used by the Southeast Asian countries, as reference in revising their respective laws and regulations aiming towards the promotion of responsible fisheries and aquaculture. A

Box 1. JTF projects implemented by SEAFDEC in Southeast Asia (1998-2019)

JTF-1: Establishment of Regional Fisheries Policy in Southeast Asia (1998-2003)

- Promotion of regional fisheries management (Sec, TD, AQD, MFRD, MFRDMD)
- Development of fish disease inspection methodologies for artificially-bred seeds (AQD)
- Development of monitoring system for substances contained in fish bodies (Sec, TD, MFRD)
- Development of mangrove-friendly shrimp aquaculture in Southeast Asian countries (AQD)
- Conservation and management of sea turtles (MFRDMD, TD)

JTF-2: Promotion of Sustainable Fisheries of Migratory Fish Stocks in Southeast Asia (2002-2007)

- Information collection for sustainable pelagic fisheries in the South China Sea and Andaman Sea (MFRDMD, TD, MFRD)
- Development of demersal fishery resources living in untrawlable fishing grounds in Southeast Asian waters (TD)
- Resources research of shared stocks in Southeast Asian waters (TD)
- Research for the safety of fisheries products in Southeast Asia (MFRD)

JTF-3: Establishment of Sustainable Regional Fisheries Systems in Southeast Asia (2003-2006)

- Environment related task in Southeast Asian region (Sec, MFRD, TD)
- Publication to enhance awareness of SEAFDEC activities on sustainable fisheries (Sec)
- Collection of information about international support in fisheries in the region (TD)
- Towards better utilization and harmonized information for fisheries management in Southeast Asia (Sec)

JTF-4: Promotion of Environment-friendly Regional Developments in Southeast Asia (2004-2009)

- Resources Conservation Program: Research and Development (R&D) of stock enhancement for species under international concern (AQD, MFRDMD, TD)
- Environment-friendly Aquaculture & Fish Disease Program: Development of fish disease surveillance system & Promotion of sustainable aquaculture (AQD, Sec)
- Research for safety of fisheries products in Southeast Asia (MFRD)
- Fishing Community Development Program: Capacity improvement of fisheries community on fisheries management and poverty alleviation (TD, Sec)

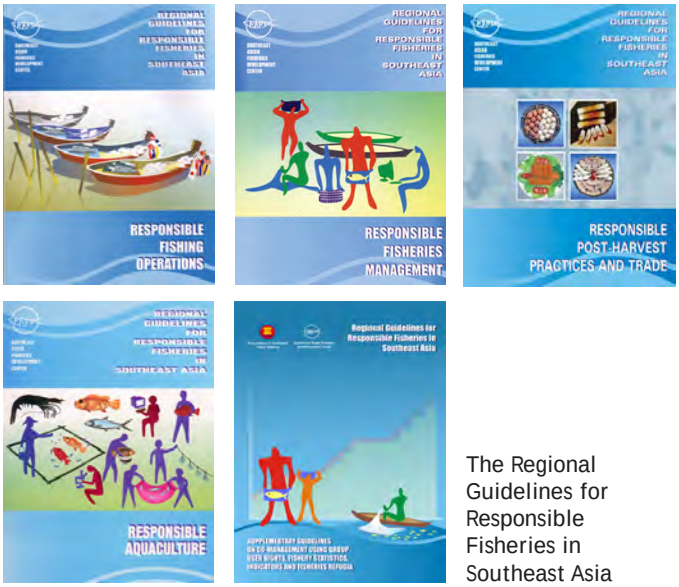
JTF-5: Promotion of Sustainable Aquaculture and Resource Enhancement (2008-2012)

- Promotion of sustainable and region-oriented aquaculture practices (AQD)
- Resource enhancement of internationally threatened and over-exploited species in Southeast Asia through stock release (AQD)
- Research and management of sea turtles in foraging habitat in the Southeast Asian waters (MFRDMD, TD)
- Research and management of sharks and rays in the Southeast Asian waters (MFRDMD, TD)
- Rehabilitation of fisheries resources and habitat/fishing grounds for resources enhancement (TD)
- Promotion of sustainable fisheries and IUU fishing-related countermeasures in Southeast Asia (TD)
- Traceability systems for aquaculture products in the ASEAN region (MFRD)
- Accelerating awareness and capacity-building in fish health management in Southeast Asia (AQD)
- Food safety of aquaculture products in Southeast Asia (AQD, MFRD)

JTF-6: Promotion of Sustainable Fisheries Management (2013-2019)

- Assistance for capacity building in the region to address international fish trade-related issues (Sec)
- Improving the data collection of the commercially-exploited aquatic species and threaten species (TD)
- Facilitating fisheries activities information gathering through introduction of community-based resources management/ co-management (TD)
- Harmonization of fishery statistics in Southeast Asian region (Sec)
- Promotion of countermeasures to reduce IUU fishing (TD)
- Combating IUU fishing in the Southeast Asian region through application of Catch Certification for international trade in fish and fishery products (MFRDMD)
- Offshore fisheries resources exploration in the Southeast Asia (TD)
- Improving post-harvest technology (MFRD)
- Comparative studies for management of purse seine fisheries in the Southeast Asian region (MFRDMD)
- Human resource development for sustainable fisheries (TD)
- Optimizing energy use and improving safety in fishing activities (TD)
- Strengthening SEAFDEC network for sustainable fisheries (Sec)
- Reinforcement and optimization of fish health management and the effective dissemination in the Southeast Asian region (AQD)
- Environment-friendly, sustainable utilization and management of fisheries and aquaculture resources (AQD)
- Research for enhancement of sustainable utilization and management of sharks and rays in the Southeast Asian region (MFRDMD)
- Promotion of sustainable fisheries resources enhancement measures in critical habitats/fishing grounds in Southeast Asia (TD)
- Enhancement of sustainability of catadromous eel resources in Southeast Asia (IFRDMD)
- Promotion of responsible utilization of inland fisheries in Southeast Asia (IFRDMD)

Note: Sec = SEAFDEC Secretariat; TD = SEAFDEC Training Department, MFRD = SEAFDEC Marine Fisheries Research Department, AQD = SEAFDEC Aquaculture Department, MFRDMD = SEAFDEC Marine Fishery Resources Development and Management Department, IFRDMD = SEAFDEC Inland Fishery Resources Development and Management Department



The Regional Guidelines for Responsible Fisheries in Southeast Asia

platform for capacity building of the human and institutional resources of the region was also provided by SEAFDEC with partial funding support from the JTF in 1998-2004, which had enabled the Southeast Asian countries to adopt the Regional Guidelines (Wanchana, 2007).

The efforts of SEAFDEC in regionalizing the CCRF received an outstanding recognition from the international community leading to the awarding of the FAO Margarita Lizárraga Medal for the Biennium 2006-2007 to SEAFDEC during its 40th Anniversary in December 2007. The Medal Award was given to SEAFDEC for its efforts in promoting the adoption of the CCRF in the Southeast Asian region, and specifically for having "served with distinction in the application of the Code of Conduct for Responsible Fisheries through the RCCRF."

Promotion of Countermeasures to Combat IUU Fishing

The continued practice of illegal, unreported and unregulated (IUU) fishing is a world-wide concern that prompted the international and regional organizations to develop and promote measures and instruments to combat IUU fishing. Developed based on the framework of the global CCRF, the International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (IPOA-IUU) being promoted by FAO, provides the comprehensive, effective and transparent measures to combat IUU fishing which the countries are encouraged to undertake for the sustainability of their fisheries in accordance with international laws.

Patterned after the IPOA-IUU, the EC Regulation 1005/2008 to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (EC IUU Regulation) is also meant to address IUU fishing problems worldwide, by requiring fish and fishery products exported to the European Union (EU) to comply with the EC IUU Regulation. Through its Presidential Task Force on Combating IUU Fishing and Seafood Fraud, the United States is also taking steps to address the IUU problems worldwide by enforcing the use of risk-based traceability systems that could track seafood from harvest until its entry to the markets in the U.S.A (Silapajarn *et al.*, 2016).

In the Southeast Asian region during the 2000s, many countries have begun to recognize the severity of the impacts of IUU fishing on the sustainable development of their respective fisheries, and thus, have been supporting the initiatives of SEAFDEC in combating IUU fishing in the region. When SEAFDEC embarked on a three-year JTF-funded project "Promotion of Sustainable Fisheries and IUU Fishing-related Countermeasures in Southeast Asia" in 2010 as a rejoinder to the Regional Guidelines for Responsible Fisheries in Southeast Asia: Responsible Fisheries Management, the ASEAN Member States (AMSs) cooperated in the project implementation by promoting in their respective fisheries sectors the need to enhance fishing licensing, boats registration and port State measures as the strategies to combat IUU fishing in the region (Torell *et al.*, 2010; Matsumoto *et al.*, 2012). Since then, SEAFDEC had been working closely with the AMSs through the mechanism established by the Fisheries Consultative Group of the ASEAN-SEAFDEC Strategic Partnership (FCG/ASSP) for the implementation of JTF-funded projects and activities on sustainable fisheries development. The technologies and outputs that emanate from such projects and activities have been disseminated to the region through training, workshops, seminars, and information dissemination activities that mostly received funding from the JTF (Pongsri *et al.*, 2011).

When the implementation of the JTF-funded project "Promotion of Countermeasures to Reduce IUU Fishing" was intensified, the AMSs sustained their efforts to collaborate with SEAFDEC for the development of management tools and measures to combat IUU fishing in the Southeast Asian region and enhance the competitiveness of the ASEAN fish and fishery products (Kawamura and Siriraksophon, 2014; Silapajarn *et al.*, 2016). Such management tools and measures include the: (1) ASEAN Guidelines for Preventing the Entry of Fish and Fishery Products from IUU Fishing Activities into the Supply Chain; (2) Regional Fishing Vessels Record Database for Vessels 24 Meters in Length and Over (RFVR Database-24 m); (3) Regional Plan of Action for Management of Fishing Capacity (RPOA-Capacity); (4) Regional Cooperation to Support the Implementation of Port State Measures; (5) ASEAN Catch Documentation Scheme (ACDS) for Marine Capture Fisheries; (6) Regional Guidelines on Traceability System for ASEAN Aquaculture Products; and (7) Strengthening of the Fishery Resources Rehabilitation Strategies to Mitigate the Impacts of IUU Fishing.

ASEAN Guidelines for Preventing the Entry of Fish and Fishery Products from IUU Fishing Activities into the Supply Chain

In accordance with the ASEAN-SEAFDEC Resolution and Plan of Action for Sustainable Fisheries for Food Security for the ASEAN Region Towards 2020 (RES and POA), SEAFDEC

with funding support from JTF, has been implementing various activities that are directed towards combating IUU fishing in the region. These included "Preventing Export of IUU Fishing Products from the Southeast Asian Region" spearheaded by MFRDMD (Latun *et al*., 2013), which came up with the *ASEAN Guidelines for Preventing the Entry of Fish and Fishery Products from IUU Fishing Activities into the Supply Chain*. This ASEAN Guidelines is aimed at establishing the foundation for the formulation of relevant policies at national level for preventing the entry of IUU fish and fishery products into the supply chain (Kawamura and Siriraksophon, 2014; Latun *et al*., 2016). In an effort to promote the implementation of the Guidelines in the region, MFRDMD has been assisting the AMSs since 2015, in addressing the issues and concerns that impede the adoption of the Guidelines in their respective countries (Latun *et al*., 2016a; Silapajarn *et al*., 2016).

Regional Fishing Vessels Record Database for Vessels 24 Meters in Length and Over

With funding support from the JTF, SEAFDEC convened a series of meetings and consultations to compile the necessary inputs for the development of a regional record of fishing vessels measuring 24 meters in length and over, to be used as a management tool for combating IUU fishing in the region (Matsumoto *et al*., 2012). Compiled by TD, the information on Regional Fishing Vessels Record (RFVR) would be used to monitor IUU fishing vessels through sharing of information on fishing vessels among the AMSs, initially focusing on large fishing vessels with length from 24 meters and over.

The corresponding RFVR Database, which is an online system is also being managed by TD (Kawamura and Siriraksophon, 2014; Pongsri *et al*., 2014). Moreover, the RFVR Database includes information on fishing vessels identification and other relevant data comprising the basic 28 elements of fishing vessels that could be shared among the AMSs (Saraphaivanich *et al*., 2016; Silapajarn *et al*., 2016).

The RFVR Database for Vessels 24 Meters in Length and Over

Regional Plan of Action for Management of Fishing Capacity

Management of fishing capacity, which is crucial for the sustainability of the fishery resources, has been given focus in the RES and POA. As a result of the series of meetings convened by SEAFDEC with partial funding support from JTF, it was agreed that the *Regional Plan of Action for the Management of Fishing Capacity (RPOA-Capacity)* should be developed as guide for the management of fishing capacity in an ASEAN perspective and to support the AMSs in the development and implementation of their respective National Plans of Action for the Management of Fishing Capacity (Amornpiyakrit and Siriraksophon, 2016; Silapajarn *et al*., 2016).

Regional Cooperation to Support the Implementation of Port State Measures in the ASEAN Region

During the series of meetings convened by SEAFDEC through TD with support from the JTF, it was agreed that regional cooperation should be established to support the implementation of port State measures, to prevent the entry of illegally-caught fish into the international markets through the countries' ports. This would also facilitate the adoption by the AMSs, of the newly-ratified Port State Measures Agreement being promoted by FAO (Saraphaivanich *et al*., 2016a; Silapajarn *et al*., 2016)

ASEAN Catch Documentation Scheme for Marine Capture Fisheries

With partial support from the JTF, the ASEAN Catch Documentation Scheme (ACDS) for Marine Capture Fisheries is being developed and promoted by SEAFDEC in the region to secure the niche of the ASEAN fish and fishery products in the global market and to serve as a unified framework in enhancing their traceability for effective marine fisheries management (Siriraksophon *et al*., 2016; Silapajarn *et al*., 2016). At the initial stage, the ACDS shall be voluntary for all AMSs but could be made mandatory later. Moreover, the implementation of the electronic format of the ACDS (eACDS) is currently being pilot-tested in the AMSs.

Strengthening Fishery Resources Rehabilitation Strategies to Mitigate the Impacts of IUU Fishing

Considering that IUU fishing activities impede the recovery of fish stocks and degrade the fishery resources, SEAFDEC with support from JTF exerted efforts in mitigating the impacts of IUU fishing on the fishery resources by improving critical habitats and enhancing the fishery resources. These had been made possible via the adoption of appropriate strategies for rehabilitating degraded fishery resources that had been developed through the JTF-funded project "Rehabilitation of Fisheries Resources and Habitats/Fishing Grounds through Resources Enhancement" implemented by TD, and "Resource Enhancement of Internationally Threatened and Over-

exploited Species in Southeast Asia through Stock Release" by AQD (Theparoonrat *et al*., 2016; Silapajarn *et al*., 2016).

Regional Guidelines on Traceability System for ASEAN Aquaculture Products

From 2010 to 2014, the JTF supported MFRD in the implementation of the project "Traceability Systems for Aquaculture Products in the ASEAN Region" which came up with the *Regional Guidelines on Traceability Systems for Aquaculture Products in Southeast Asia* (Yeap, 2016). Mainly aimed at securing the niche of ASEAN fish and fishery products in the global market, the Regional Guidelines also serves as guide in implementing traceability systems for aquaculture products which had been included as part of the requirements for the trading of these products in the global market, as well as in formulating national programs and activities that aim to promote fishery products' traceability (Yeap, 2016; Silapajarn *et al*., 2016).

Conservation of Commercially-exploited Aquatic Species: Sharks and Rays

During the recently-conducted Conferences of Parties (CoP) to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), several species of sharks and rays have been listed in the CITES Appendices. In an attempt to address this concern, SEAFDEC through TD has organized several JTF-funded fora to establish data collection methodology for the assessment of the stocks of sharks and rays in the Southeast Asian region. Although sharks and rays are not target species of the region's fisheries, a standardized catch per unit effort (CPUE) for specific types of fishing gear, *e.g.* trawl, gill net, purse seine, long line, hand line, had been developed (Chamsai *et al*., 2013).

Efforts have also been exerted by TD to improve the collection of information on sharks and rays including the compilation of conservation measures to obtain the necessary scientific evidence on the status of the stocks of sharks and rays in Southeast Asia. In order to provide guidance to the AMSs in improving the compilation of their national landings of sharks and rays up to species level, MFRDMD published a number of elasmobranchs taxonomy books and learning materials starting in 2006 (Wanchana *et al*., 2016). Thus, SEAFDEC with support from JTF continued to organize a series of technical meetings since 2011 to enable the AMSs to develop their respective National Plans of Action on Conservation and Management of Sharks and Rays (NPOA-Sharks) based on the International Plan of Action of the Conservation and Management of Sharks (IPOA-Sharks) promoted by FAO since 1999. Starting in 2015, the JTF also co-funded with the EU-CITES a one-year project on sharks and rays data collection in seven countries of Southeast Asia, which came up with the *Standard Operating Procedures (SOPs) on Sharks Data Collection in Southeast Asia*. The SOPs serves as guide and reference for enumerators from the project participating countries during their activities related to the compilation of the landing data on sharks and rays (Wanchana *et al*., 2016a).

Training of enumerators for identifying species of sharks and rays

Conservation of Commercially-exploited Aquatic Species: Sea Turtles

Concerns on the indiscriminate exploitation of sea turtles worldwide had become quite severe prompting the International Union for Conservation of Nature (IUCN) to declare that all species of sea turtles are endangered. To address such concern, SEAFDEC through its MFRDMD embarked in 1998, a 10-year JTF-funded project "Conservation and Management of Sea Turtles" (Mohd. Isa *et al*., 2008). During its implementation, the project had not only compiled the information on the status of research, conservation and management activities of sea turtles in Southeast Asia, but also established a mechanism for regional collaboration on the research and conservation of sea turtles.

Six of the seven sea turtle species found in the world are inhabiting the Southeast Asian waters (Talib *et al*., 2003), and the AMSs have exerted efforts to conserve these important aquatic species considered as threatened and faced the risks of being unable to maintain their stocks. The sea turtles found in the region are the leatherback turtle (*Dermochelys coriacea*), green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), olive Ridley (*Lapidochelys oliviacea*), loggerhead turtle (*Caretta caretta*), and the flatback turtle (*Natator depressus*). Specifically, these six species are nesting across the Southeast Asian waters except for the flatback which is reported to mostly inhabit the Indonesian waters (Talib *et al*., 2003).

Leatherback turtle

Green turtle

Hawksbill turtle

Olive Ridley turtle

Loggerhead turtle

Flatback turtle

During the first phase of the project implementation, MFRDMD developed the techniques for sustainable hatchery management of the green turtle that were published in *A Guide to Set and Manage Sea Turtle Hatcheries in the Southeast Asian Region* (Mohd. Isa *et al*., 2008; Ali *et al*., 2004).

Since sea turtles are highly migratory, MFRDMD also carried out sea turtle tagging experiments in the waters of many Southeast Asian countries. The outputs of the experiments included information on migration patterns, growth and mortality rates, reproduction and population estimates, among others (Ali *et al*., 2006), especially for the green, hawksbill and olive Ridley turtles. While the results indicated that these sea turtles share the same resources, MFRDMD was also able to identify their foraging areas in the Southeast Asian region.

TD also collaborated with MFRDMD through the implementation of the activity "Reducing Interactions and Mortality of Sea Turtles due to Fishing." This led to the development of Turtle Excluder Devices (TEDs) that is suitable for the region and promotion of the TEDs in the Southeast Asian Region through capacity and awareness building leading to the adoption of the TEDs in many Southeast Asian countries (Chokesanguan, 2008).

For the second phase of the project, studies on the stock and population of sea turtles were carried out by MFRDMD. In green turtles, the results showed that their frequency distributions have eight genetically distinct breeding stocks, the female adult green turtles laying eggs at particular nesting beaches belong to one sub-population, and that several sub-populations of female green turtles are found in the Southeast Asian waters. In order to guide the Southeast Asian countries in collecting turtle tissue samples, MFRDMD published the *Standard Operating Procedure: Sampling Tissue of Sea Turtles in the Southeast Asian Region* (Syed *et al*., 2006). In addition, the *Conceptual Framework on Cloning of Sea Turtles* that contains the methodologies and techniques of cloning sea turtles (MFRDMD, 2006) and the *Master Plan: Cloning of Sea Turtles* describing the establishment of advanced reproductive biotechnology and captive breeding for the sustainable management of sea turtles (MFRDMD, 2006a) were published.

Turtle tagging experiments

Turtle released from fishing gear installed with TED

The enhanced regional collaboration and partnerships in sea turtle conservation and management in the region has been a significant impact of this JTF-funded project. During the implementation of the project, the ASEAN Network on Sea Turtles was established as a regional task force in the promotion of conservation and management of sea turtles in the region, while the Turtle Database System was developed which had since then been promoted in the Southeast Asian region in cooperation with SEASTAR2000 for the satellite tracking of sea turtles. Results of the studies conducted under the project were compiled and published in the *Conservation and Enhancement of Sea Turtles in the Southeast Asian Region* (Zulkifli *et al*. (eds), 2004). Based on the results of this JTF-funded project, MFRDMD in collaboration with the SEAFDEC Member Countries developed the *Regional Plan of Action of Marine Turtle Foraging Habitats in Southeast Asian Waters* which is meant to ensure that the sea turtles and the ecosystem of their foraging habitats are well managed

and protected, and that poaching of sea turtle eggs in nesting areas is reduced.

Promotion of Selective Fishing Gears

In the promotion of responsible fishing operations in the region, SEAFDEC through TD and with support from the JTF intensified the development of measures and regulations that included the adoption of selective fishing gears and practices in the Southeast Asian countries. Advocated as means of minimizing the catch of juveniles and immature fishes by trawlers, the use of Juvenile and Trash Fish Excluder Devices (JTEDs) had been demonstrated in the region in collaboration with concerned Southeast Asian countries (Tsubata, 2008). The successful demonstration in the Philippines prompted the Philippine Government to issue a regulation on the installation and use of JTEDs in all trawlers operating in the country (Chokesanguan *et al*., 2010).

Intensifying the Promotion of the Regional Fish Disease Project

With the continued support from the JTF, SEAFDEC has been promoting responsible aquaculture as a long-term strategy for economic development in the Southeast Asian region, considering that aquaculture has the potential of stabilizing the supply of fish and fishery products as production from capture fisheries had been dwindling. Issues and concerns on the sustainability of aquaculture have been continuously addressed by SEAFDEC through AQD so that aquaculture would remain sustainable, technically feasible and economically viable, as well as environment-friendly and socially equitable (Platon *et al*., 2007).

One of the major concerns in the promotion of sustainable aquaculture in Southeast Asia is the occurrence and speedy spread of aquatic diseases that could threaten the sustainability of the region's aquaculture industry. In an effort to address this concern, AQD with support from the JTF implemented the "Regional Fish Disease Project" in order that healthy and wholesome aquaculture products are generated from the region's aquaculture sector, and that emerging viral diseases in aquatic animals are prevented and controlled. The Project was implemented in two phases, *i.e.* Development of Fish Disease Inspection Methodologies for Artificially-bred Seeds, and Development of Surveillance Systems of Diseases in Aquatic Animals. Implemented from 2000 to 2005, the "Development of Fish Disease Inspection Methodologies for Artificially-bred Seeds" included a study on the diagnosis of the koi herpes virus (KHV) disease which had caused mass mortalities of carps in the Southeast Asian region threatening the sustainability of the region's freshwater aquaculture industry (Nagasawa, 2005).

Results of the Project Phase 1 included the establishment and standardization of diagnostic methods for the various viral diseases in cultured shrimps and fishes which had caused devastations of the region's aquaculture production. These viral diseases include among others, the white spot syndrome virus (WSSV) of the black tiger shrimp *Penaeus monodon*, and viral nervous necrosis (VNN) of marine fishes (Ogata, 2009). Specifically, the diagnostic methods, *i.e.* polymerase chain reaction (PCR) for the WSSV had been standardized; the methods for preventing and controlling VNN infection in marine fish hatcheries developed; and the husbandry techniques to control the luminous vibriosis caused by *Vibrio* spp., a common bacterial disease that affected the shrimp

aquaculture industry of the region, had been established. The findings from Project have been disseminated to the region through training that includes not only classroom-type training but also distance-learning style that allows the learners to acquire knowledge and skills in fish health management at their respective work stations (Ogata, 2009).

Implemented from 2004 to 2009, the "Development of Fish Disease Surveillance System in Southeast Asia" was aimed at assisting the AMSs in their efforts in fish health management, especially in instituting surveillance systems for important viral diseases for cultured shrimps and fishes. As a result, the countries have developed a well-coordinated network for the timely and efficient reporting on aquatic animal diseases outbreaks in the region (Ogata, 2009), and have sustained their efforts in monitoring and surveillance of the occurrence of emerging aquatic animal diseases. From 2008 to 2012, AQD with support from JTF continued to refine the diagnostic methods and kept abreast with the new preventive methods for emerging aquatic animal diseases.

The recent outbreaks of the acute hepatopancreatic necrosis disease (AHPND) that causes early mortality syndrome (EMS) in shrimps in the region, the newly emerging disease known as the hepatopancreatic microsporidiosis (HPM) caused by enterocytozoon hepatopenaei (EHP) that leads to severe growth retardation in cultured shrimps, and other transboundary diseases that threaten the sustainability of the region's aquaculture industry, prompted SEAFDEC through AQD with support from JTF, to implement the five-year project "Reinforcement and Optimization of Fish Health Management and their Effective Dissemination" starting in 2013. This five-year project generally aims to address the concerns of the AMSs in preventing and controlling the occurrence of emerging aquaculture diseases (Pakingking and de Jesus-Ayson, 2016). Based on these developments, the SEAFDEC Council of Directors recommended that cooperation among the countries should be strengthened to immediately address the incidence of aquatic animal diseases and that a regional early warning system should be established by SEAFDEC through the AQD in collaboration with the Bangkok-based ASEAN Network of Aquatic Animal Health Centres (ANAAHC) to alert the countries in the region should an outbreak of aquatic animal disease occur in one country.

Maximizing the Utilization of Fish Catch

The full support that the JTF has accorded to SEAFDEC for the promotion of responsible post-harvest practices and trade in the region has enabled the AMSs to advance the production of safe and wholesome fish and fishery products, and maximize the utilization of fish catch. Through the efforts of MFRD, SEAFDEC has been able to assist the region's fish processing industries in meeting the quality assurance requirements through the application of Hazard Analysis and Critical Control Point (HACCP), Good Manufacturing

Practices (GMPs) and Standard Sanitation Operation Procedures (SSOPs), among others (Goh and Yeap, 2007). As a result, GMPs and SSOPs have been practiced for small and medium-sized fish processing establishments (SMEs) in many countries of the region, especially in Indonesia (Mulyani and Idawati, 2007).

In the late 1970s, the region's landings of low-value fishes had increased due to the expansion of trawl fisheries in the region. This had prompted SEAFDEC through its MFRD to find the ways and means of promoting the efficient utilization of the fish catch for human consumption. Thus, with support from JTF, SEAFDEC has promoted the production of safe and wholesome fishery products such as the frozen surimi, through improved fisheries post-harvest technology, which generally aims for the maximum utilization of the fish catch, development of fishery products from low-value fish resources to minimize wastage, and improvement of the handling, preservation and quality of the region's fish and fishery products (Goh and Tan-Low, 2008). At the outset of the refinement of fisheries post-harvest technologies, MFRD made use of low-value fish as raw materials to produce not only the comminuted fishery products but also surimi. With continued support from the JTF, MFRD had perfected the technology of producing frozen surimi which had been transferred to the Southeast Asian countries through training and extension activities (Siriraksophon *et al*., 2009).

Such efforts of MFRD resulted in the successful promotion of surimi and surimi-based products for domestic consumption as well as for export, and brisk growth of the surimi industry in many Southeast Asian countries (Goh and Yeap, 2007). This is considering that surimi production in Southeast Asia in early 1970s was almost nil and the fishery products then comprised only fish balls and fish cakes (Yeap and Chow, 2011; Pongsri *et al*., 2015).

Production of traditional fishery products is an age-old backyard industry in many Southeast Asian countries, where the products had been originally meant for domestic consumption. The increasing demand of these products not only in domestic market but also in the global market

necessitated their improvement to comply with the safety and quality standards, and other requirements to secure a niche for such products in the global market (Goh and Yeap, 2007). With continued support from JTF, MFRD developed and promoted various guidelines on food safety measures such as good manufacturing practices (GMPs) and standard sanitation operating procedures (SSOPs), and assisted the small and medium enterprises in implementing such measures through training and extension (Yeap and Chow, 2011).

Boosting the Sustainable Management of Fishery Resources

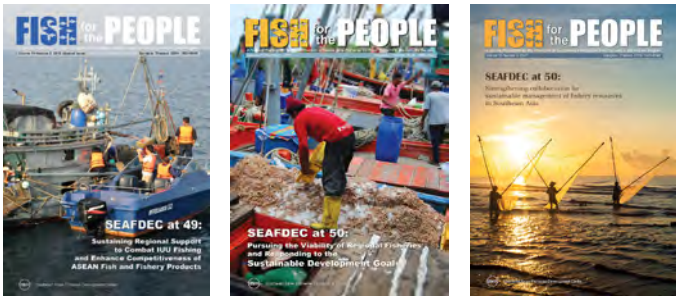
For better understanding of the region's fishery resources as basis for sustainable fisheries management, SEAFDEC through its Marine Fishery Resources Development and Management Department (MFRDMD) and with support from JTF has enhanced the compilation of scientific and technical information that includes improvement of data collection, analysis, interpretation, and presentation.

MFRDMD has also been assisting the Southeast Asian countries in the promotion of responsible fisheries management by strengthening the management of their respective coastal and inland fisheries. This has been attained by the countries through the adoption of the concepts of rights-based and co-management in fisheries, as well as management of overcapacity in coastal areas (Tsubata, 2008).

Upon the establishment of the SEAFDEC Inland Fishery Resources Development and Management Department (IFRDMD) in 2014, SEAFDEC with support from the JTF embarked on the implementation of projects that focused on the management of inland capture fisheries. These projects which are ongoing include "Enhancement of Sustainability of Catadromous Eel Resources in Southeast Asia" and "Promotion of Responsible Utilization of Inland Fisheries in Southeast Asia." With funding support from the JTF, a survey of the catadromous eel resources in the Southeast Asian region had been initiated by IFRDMD to understand the current status of Anguillid eel resources in the region (Mutmainnah *et al*., 2016). This activity is now being intensified through the collaborative project between JTF and the Japan-ASEAN Integration Fund (JAIF). Moreover, with JTF support, a study on the sustainable management of inland capture fisheries in the Southeast Asian region is being pursued by IFRDMD taking into consideration the experience of Indonesia on this aspect (Utomo and Samuel, 2017).

Promoting the Outputs of the Implementation of JTF Projects

The Special Publication *Fish for the People* has been playing an important role in raising the awareness of the stakeholders on the achievements of SEAFDEC and the Member Countries from the implementation of regional projects and activities on responsible fisheries. Fully supported by the JTF, *Fish for the People* is published by the SEAFDEC Secretariat tri-annually and as of December 2017, 15 volumes with 43 issues had been produced.



Aimed to support the promotion of sustainable fisheries for food security in the Southeast Asian region, *Fish for the People* was launched in early 2003 with its maiden issue Volume 1 No. 1 (2003), intended to commemorate the first anniversary of the ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security in the New Millennium: "Fish for the People" organized in November 2001, from which the Special Publication got its banner title *Fish for the People* (SEAFDEC, 2013). The Special Publication has been acclaimed by the academe, various organizations as well as by research and development institutions, as an important source of information that could be used as reference in their works related to the sustainable development of fisheries in the Southeast Asian region.

Way Forward

The role of the JTF in providing financial assistance that enabled SEAFDEC to implement projects and activities on sustainable fisheries in the Southeast Asian region is very significant, as the "return of JTF investments" during the past 20 years, has been very much profitable in terms of the efficient utilization by the SEAFDEC projects and activities of the available resources against the tangible results that have been disseminated to the Southeast Asian countries, leaving an indelible JTF imprints on the minds of the stakeholders. With the continued financial assistance provided by the Government of Japan through the JTF, SEAFDEC has been

successful in transforming the status of the region's fisheries from being production-oriented to sustainability. Thus, in the past 20 years, fisheries production from the Southeast Asian countries had continuously soared higher making the region one of most reputable in terms fisheries production.

Beyond its 20-year active involvement in the sustainable development of fisheries in Southeast Asia, the JTF would use the achievements of the SEAFDEC projects and activities to weigh the anchor for the seventh phase of the JTF, *i.e.* JTF-7. Although still undergoing negotiations with the Fisheries Agency of Japan, the JTF-7 is planned to start in 2020.

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Managing Purse Seine Fisheries in the Southeast Asian Region: a joint effort among ASEAN Member States

Mohammad Faisal Md. Saleh, Wahidah Mohd Arshaad, Raja Bidin Raja Hassan, Noorul Azliana Jamaludin, and *Nurul Nadwa Abdul Fatah*

Production from marine capture fisheries of the Southeast Asian region is derived from the fishing grounds in the South China Sea and Andaman Sea of the Indian Ocean (**Fig. 1**), comprising FAO Fishing Area 57 (Indian Ocean, Eastern), Area 61 (Pacific, Northwest), and Area 71 (Pacific, Western Central). In the Southeast Asian region, small pelagic fishes such as round scads, mackerels, sardines, and anchovies are considered as important components of the marine ecosystem and pelagic fishery resources. The migratory behavior of small pelagic fishes had made them known as "shared stocks" since they migrate across the exclusive economic zones (EEZs) of neighboring countries. Considering the likelihood that such stocks are shared by the bordering countries within the same ecosystem, *i.e.* in the South China Sea and the Andaman Sea, effective management of the shared stocks would require appropriate measures at the regional level. Nevertheless, delaying the regional approach in managing these stocks will further expose the small pelagic fishes to overexploitation that are now probably at unsustainable level (SEAFDEC, 2012).

Purse seine is one of the major fishing gears used to exploit small pelagic fishes in the region. Many types of purse seines are used to catch small pelagic fishes, among them are fish purse seine, anchovy purse seine, Thai purse seine, luring purse seine, tuna purse seine, and others. Commonly, purse seine operations are associated with fish aggregating devices (FADs), luring lights, and other devices. Nowadays, modern purse seines are equipped with radar, depth sounder, sonar transceiver, and satellite navigational instruments (SEAFDEC, 2017). However, management of purse seine fisheries has not been considerably pursued because of inadequate information on the stocks of the small pelagic fishes (Raja Bidin and Latun, 2016).

In an effort to establish a management plan for commercially important small pelagic fishes, the Marine Fishery Resources Development and Management Department (MFDRMD) of SEAFDEC was given the mandate to embark on the seven-year project "Comparative Studies for Management of Purse Seine Fisheries in the Southeast Asian Region" starting 2013. Funded by the Japanese Trust Fund VI (JTF-6), the project involves eight ASEAN Member States (AMSs) that border the South China Sea (SCS), an important fishing area of these coastal states, namely: Brunei Darussalam, Cambodia, Indonesia, Malaysia, Myanmar, Thailand, Philippines, and Viet Nam. As this point in time, the project has compiled the catch-effort statistics and reviewed the appropriate measures for management of small pelagic fisheries in the Southeast Asian region. In addition, a genetic study is being conducted to verify the extent of connectivity among the commercially important small pelagic fishes targeted by purse seine fisheries.

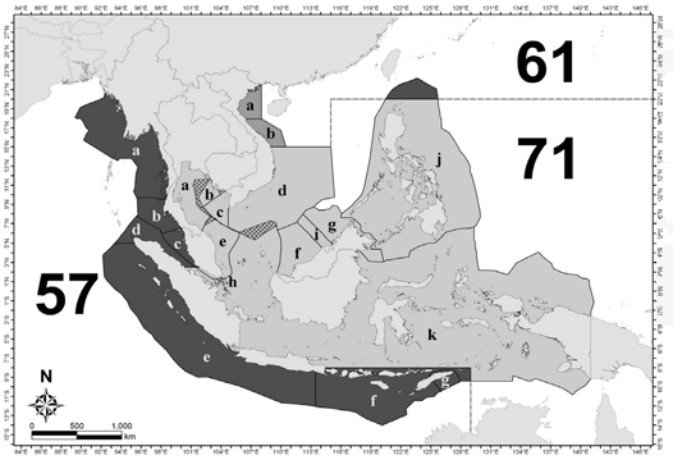

Fig. 1. Fishing areas 57, 71 and 67, with respective sub-areas (SEAFDEC, 2008; adapted from FAO)

The results would provide scientific background for concerted actions of the AMSs for the management of shared stocks of small pelagic fishes as well as development of appropriate management strategy for purse seine fisheries in the region.

Compilation of Catch-effort Statistics for Purse Seine Fisheries

Considering that fisheries catch-effort statistics are available in some AMSs and catch per unit effort (CPUE) is an indirect measurement of abundance of a target species, MFRDMD has examined the trend of resource level using the CPUE. At the same time, MFRDMD also reviewed the purse seine fisheries management systems including total allowable catch (TAC) and other measures to analyze the most appropriate system or measure that is applicable for the management of small pelagic fisheries in the Southeast Asian region (Raja Bidin and Latun, 2016). Taking place from 2013 until now, MFRDMD had continuously collected the updated information on purse seine fisheries from the AMSs as well as assessed the data for regional synthesis to recommend stock indicators and management systems that are suitable in the region. Every AMS has therefore been requested to provide updated and detailed information on their respective purse seine fisheries by complying with the parameters established by MFRDMD as shown in **Table 1**.

Nevertheless, there are some issues on the reliability of the compiled data because some countries are not able to fulfil all of the parameters, especially on the number of vessels for fish purse seine and anchovy purse seine. If this constraint continues to occur, it may affect the final analysis because the fishing efforts will be used in calculation of CPUE which is the key component of the project. The CPUE that will be analyzed from the catch and

Table 1. Parameters necessary for the management of purse seine fisheries in the Southeast Asian region

Parameters	Details
Landing of purse seine fisheries	• Trend of landing • Species composition • Biological information - length at maturity (Lm) - spawning season
Fishing effort for purse seine fisheries	• No. of vessels (fish purse seine, anchovy purse seine) • Weight of vessels (GRT) • No. of days/trip • No. of trips/month • No. of hauls/day • Trend of CPUE - by vessel - by trip - by days
Status of pelagic fish stock	• Biomass • Maximum sustainable yield (MSY)
Existing management strategies	• Closed Season • Closed Area • Survey-explorations • Joint venture program

effort statistics (*i.e.* number of vessels) will be used to calculate the allowable biological catch (ABC). The calculated ABC shall then serve as a scientific guide to set the annual TAC for the management of purse seine fisheries in this region.

The most recent information based on the parameters indicated in **Table 1** was presented by each AMS and discussed during the Third Core Expert Meeting on "*Comparative Studies for Management of Purse Seine Fisheries in the Southeast Asian Region*" in September 2017 in Kuala Lumpur, Malaysia. Based on the issues and challenges raised during the meeting, all of the AMSs were aware of the importance of reliable statistics to develop an appropriate management of purse seine fisheries. Thus, a detailed catch-effort statistics in the region should be prioritized to uphold accurate information.

Genetic Study

The spotted sardinella, *Amblygaster sirm* (**Fig. 2**) was chosen for genetic study because of its recognizable morphological features. *A. sirm* can be distinguished easily from other species of sardines by the presence of a series of 10 to 20 gold spots (in live or fresh specimens) or black spots (in preserved specimens) along the lateral line, but sometimes the spots are missing. This species is widespread in tropical Indo-West Pacific from the Red Sea and Madagascar, eastward to Indonesia, Gulf of Thailand, New Guinea, and the Philippines; north to Taiwan Province of China, and Okinawa (Japan); southward to northern coasts of Australia and New Caledonia; eastward to Kiribati and Fiji (Carpenter and Niem, 1999) as shown in **Fig. 3**.

In carrying out the genetic study of *A. sirm*, sampling locations were established in the South China Sea (Zambales and Palawan in the Philippines; Kudat, Kuching, and Kuantan in Malaysia; Muara in Brunei; and Songkhla in Thailand), and in the Andaman

Fig. 2. Spotted sardinella (*Amblygaster sirm*)

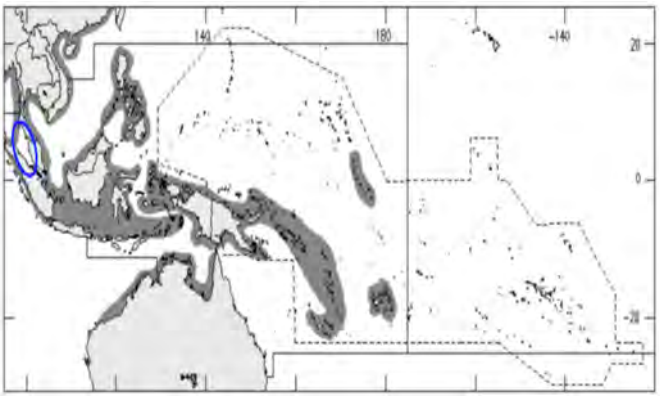

Fig. 3. Distribution of spotted sardinella, *Amblygaster sirm* (highlighted in dark gray). *A. Sirm* could not be found in the Strait of Malacca, in blue circle (Carpenter and Niem, 1999)

Sea (Ranong in Thailand) as shown in **Fig. 4**. The samples were collected from the South China Sea (n = 217) and the Andaman Sea (n = 35) from January to September 2015. *A. sirm* specimens were analyzed using DNA mitochondrial cytochrome *b* marker.

Based on the 1016 bp inferred by mitochondrial DNA cytochrome *b*, the stocks of *A. sirm* between the South China Sea and the Andaman Sea are separate genetic units. This indicates that the populations in the South China Sea are not associated with the populations in the Andaman Sea. It should be noted that this species could not be found in the Strait of Malacca (Carpenter and Niem, 1999) which could be the main reason of separation of the stock structure.

As for the management of sustainable fisheries, *A. sirm* in the South China Sea and the Andaman Sea should be regarded as a separate fishery resource that can be managed separately. Therefore, factors that affect the population in the South China Sea, such as fishing pressure, will not affect the population in the Andaman Sea, and vice versa. However, this is only a preliminary result due to limited number of samples. Therefore,

Fig. 4. Sampling locations of spotted sardinella (*Amblygaster sirm*) in the South China Sea and the Andaman Sea for genetic study (in blue dots)

it is recommended that additional specimens are needed especially from the Andaman Sea that would be sourced from the waters of Indonesia and Myanmar. Hence, the use of other methodologies using different DNA markers could be applied to confirm the initial findings.

Recommendations and Way Forward

The migratory behavior of small pelagic fishes poses a great challenge in the development and management of sustainable fisheries. Even though the preliminary result of genetic study found that populations of one of the target species, *A. Sirm*, in the South China Sea and the Andaman Sea are separate stocks, majority of the pelagic fishes are being shared by many countries in the region. Since purse seine is the main fishing gear used to exploit the small pelagic fishes, it is possible that purse seines operating in both ecosystems (the South China Sea and the Andaman Sea) might exploit the same stocks of small pelagic fishes. Hence, it is necessary that such shared stocks should be well managed to prevent overexploitation that could probably lead to the decline of the stocks.

In order to promote the fisheries management in the region, acknowledging the shared stocks is vital (SEAFDEC, 2017). Thus, in view of direct impact of purse seine fishery on the shared stocks of small pelagic fishes, it is essential to implement suitable management measures exclusively for purse seine fisheries in the region (SEAFDEC, 2012). In the early stages of the project, MFRDMD and AMSs reviewed the TAC as a possible measure to manage purse seine fisheries in the Southeast Asian region. However, it was found that TAC is not applicable due to the multispecies catch composition of the purse seine fisheries, thus other management measures must be considered. Among other management measures are the total allowable effort (TAE), allowable biological catch (ABC), and allowable biological effort (ABE).

Upon consultation with *Dr. Takashi Matsuishi* from Hokkaido University, Japan, the Resource Person for the Project, it was agreed that either ABC or ABE would be the most appropriate management measure for multispecies catch composition of purse seine fisheries in the Southeast Asian region. It was based on the feedback control that was introduced by *Dr. Matsuishi* which refers to cause-effect relationship. In fisheries, feedback control exemplifies the actions taken by managers according to the current state of the fisheries, management objectives, and a decision algorithm in a feedback control loop, typically aiming to stabilize annual catches and population abundances at desired levels (Holt and de la Mare, 2009). In the project's feedback control, Rule 2-1 and Rule 2-2 were constructed based on two assumptions, namely: (1) CPUE is proportional to the population; and (2) catch trend will correspond to short term population trend, respectively. These rules are being considered as the most applicable and appropriate for the management of purse seine fisheries utilizing the available data.

Since MFRDMD plans to publish a regional synthesis of purse seine fisheries in Southeast Asia, an internal workshop will be organized during the first quarter of 2018 for the preparation of the said regional synthesis. Besides, MFRDMD will also convene a Core Expert Meeting in late 2017 year or early 2018 to report on the information gathered during the project period and discuss about purse seine fisheries management in the Southeast Asian region. As for the genetic study, the analysis of specimens from other locations will be continued.

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Strengthening Regional Cooperation to Support the Implementation of Port State Measures in Southeast Asia

Kongpathai Saraphaivanich, Yanida Suthipol, and *Namfon Imsamrarn*

Illegal Unreported and Unregulated (IUU) fishing is a global threat to sustainable fisheries and to the management and conservation of fishery resources. As a tool to combat IUU fishing, enhanced port State control has increasingly gained importance throughout the last decennium. The growing reliance on port States to combat non-sustainable fishing practices stems to a great extent from the failure of flag States to effectively control fishing operations carried out by vessels flying their flag. Port State Measures (PSM) are requirements established or interventions undertaken by port States in which a foreign fishing vessel must comply with or is subjected to as a condition for use of ports within the port State. National PSM would typically include requirements related to prior notification of port entry, use of designated ports, restrictions on port entry and landing/transshipment of fish, restrictions on supplies and services, documentation requirements, and port inspections, as well as related measures, such as IUU vessel listing, trade-related measures and sanctions. Many of these measures have in recent years seen their inclusion and development in international instruments.

Since the late 1990s, a number of international fora have called for the need to combat IUU fishing, and in March 2001, the FAO Committee on Fisheries (COFI) adopted the International Plan of Action to Prevent, Deter and Eliminate IUU fishing (IPOA-IUU) which is being applied on a voluntary basis. A large and diverse set of measures for States was bounded to combat IUU fishing, individually and in collaboration with other States. Some of these measures are designed to be used by all States; others are tailored for application by flag States, coastal States, and port States (SEAFDEC/TD, 2016).

Fishing port at Songkhla Province, Thailand

The Food and Agriculture Organization (FAO) has played a leading role in strengthening the coordination of Port State Measures (PSM) and other surveillance activities, and in maximizing the benefits from such activities. This culminated in the acknowledgement by the FAO Committee on Fisheries (COFI) at its Twenty-sixth Session in 2005 that there was a need to strengthen PSM as a means of combating IUU fishing in a more substantive manner given that the lack of agreed and binding measures had provided a loophole. After their endorsement of the FAO Model Scheme on Port State Measures to Combat IUU Fishing, COFI agreed that follow-up work should be undertaken, especially with respect to the implementation of standards and model of control measures which FAO had developed for adoption in fishing ports (Saikliang *et al*., 2012).

The regional fisheries management organizations (RFMOs) have been increasingly adopting the PSM which had also been addressed in a number of international instruments. Acknowledging that there was an urgent need for a comprehensive suite of PSM, COFI endorsed the initiative to develop a legally binding agreement on port State measures based on the FAO Model Scheme and the IPOA-IUU. Thus, the Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (PSM Agreement) was approved during the Thirty-sixth Session of COFI in November 2009 (Saikliang *et al*., 2012). In October 2017, the instruments to adhere to the PSM Agreement had been deposited by 49 States and one member organization (*i.e.* EU).

In the Southeast Asian scene, the Plan of Action on Sustainable Fisheries for Food Security Towards 2020 which was adopted during the ASEAN-SEAFDEC Conference Fish for the People 2020 "Adaptation to a Changing Environment" in Bangkok, Thailand in June 2011, emphasized the need to build up capacity among ASEAN Member States (AMSs), including functions for regional and sub-regional cooperation, to effectively meet the requirements of port State measures and flag State responsibilities (SEAFDEC/TD, 2013). In support of the implementation of PSM for the Southeast Asian region, and in anticipation of the entry to enforce the PSM and the need for strengthened regional cooperation, the SEAFDEC Training Department (TD) implemented the project "Promotion of Countermeasures to Reduce IUU

Fishing" for the period 2012-2019 with funding support from Japanese Trust Fund (JTF). Under the Project, PSM activities had been promoted in the AMSs through series of meetings and workshops organized by TD including the "Experts Group Meeting on Port State Measures in Southeast Asia" (November 2012), "Experts Meeting on Regional Cooperation to Support the Implementation of Port State Measures in Southeast Asian Region" (February 2016), and "Workshop on Regional Cooperation for Implementation of Port State Measures to Improve Fisheries Management and Reduce IUU Fishing in Southeast Asia" (November 2016). The recommendations from all such meetings emphasized

Table 1. Recommendations for regional cooperation to implement the PSM Agreement in Southeast Asia (SEAFDEC/TD, 2017)

Refers to the PSM Agreement		Recommendations for Regional Cooperation on PSM implementation	Actions and Needs
PART	**Article No.**		
Entry into Port	**Article 7:** Designated port	• Encourage AMSs to identify designated ports for foreign fishing vessels and discourage foreign fishing vessels from unloading fish and fishery products in non-designated ports	• AMSs shall share the information on ports with FAO and SEAFDEC. the AMSs without designated ports must learn the criteria, identification, and analysis • Establishment of a guide for port designation including procedures, information dissemination, and so on
		• Include in the list of designated ports such information as the name of the port, address, contact person and his/her designation as well as official website with English version	• SEAFDEC shall publicize the information on AMS's designated ports
	Article 8: Advance request for port entry	• AMS shall provide, as a minimum standard, the information requested in Annex 1 of the PSM Agreement or relevant document to be adopted by AMS to be provided before granting entry to a vessel to its port	• The AMSs should provide information on Regional Fishing Vessel Record (RFVR) to SEAFDEC as a tool to support the implementation of PSM not only for vessels 24 meters and over, but also below 24 meters as planned for the future development of the RFVR Database • Expand existing RFVR to support the Annex 1 including history of compliance • The RFVR should include vessels less than 24 meters, especially those that use foreign ports, but not artisanal vessels (considering the near-real time updating of the existing RFVR Database)
	Article 9: Port entry, authorization or denial	• Share information on the country's laws and regulations among the AMSs taking into account the situation where some AMSs (*e.g.* Malaysia and Indonesia) do not allow their fishing vessels excluding carriers to unload catch at ports in the respective countries	• Organize regional workshops to share and discuss laws and regulations • Develop a regional website and database system where English version of laws and regulations of all AMSs will be published • Encourage the use of existing Port lex (FAO database), SEAFDEC website, and RPOA-IUU website for sharing laws and regulations • Translate national laws and regulations into English for wider audience, in which the resources and support could be requested from FAO
		• Encourage AMSs to require foreign fishing vessels and carriers to submit pre-arrival information (such as approval to land catch, origin of catch or certificate of catch) so that the port State can decide whether to authorize or deny the entry of such vessel into their port. Decision to deny shall be communicated to the flag State	• Conduct Regional Training on the implementation of PSM for Brunei Darussalam, Cambodia, and Viet Nam for their stakeholders to understand the process of PSM • Develop a minimum standard of pre-arrival information (*e.g.* ACDS) • Share the results of inspection on port entry, authorization or denial among coastal States and flag States, and regional organizations such as FAO, SEAFDEC, and RPOA-IUU • Discuss the black list of foreign fishing vessels and carriers
		• Provide awareness building to relevant stakeholders (*e.g.* fishing boat owners, importers, port authority officials and staff, etc.) at national level to enhance better understanding of the country's laws and regulations, and other procedures on inspections	• Develop Training of Trainers Workshops (train the target stakeholders, etc.) and produce multi-media materials (posters, IEC, etc.) to make it applicable in the local context • Create communication strategy and roadmap such as development of PSM webpage that contains country profile, laws and regulations, and FAO materials and lessons • Organize training on implementation of PSM for stakeholders, fisheries managers, fisheries policy makers, and inspectors

Table 1. Recommendations for regional cooperation to implement the PSM Agreement in Southeast Asia (SEAFDEC/TD, 2017) (Cont'd)

Refers to the PSM Agreement		Recommendations for Regional Cooperation on PSM implementation	Actions and Needs
PART	Article No.		
Inspections and Follow-up Actions	**Article 12:** Levels and priorities for inspection	• Adopt the Standard Operating Procedures (SOPs) on risk assessment and inspection of vessels through harmonization during consultations or workshops	• Organize a regional workshop in collaboration with relevant partners on the development of SOPs for risk assessment and inspection of vessels focusing on the target group from port managers, operational level, inspectors, and technical level • AMSs should prepare the information on vessels for the development of SOPs on risk assessment prior to the development of SOPs
		• AMS to consider minimum levels for inspection of vessels through, as appropriate, agreement among all other AMSs • Support inspection of the vessels where the historical data/information of vessels should be required in the database module of vessels	• Promote the use of RFVR and eACDS • Apply RFVR Database system in field work
	Article 15: Transmittal of inspection results	• AMS to transmit the results of each inspection to the flag State of the inspected vessels • AMS to submit to SEAFDEC the total number of inspections conducted annually • Port State to share the summary report of inspection to SEAFDEC, when AMS flagged vessel has been denied entry, denied the use of port, or denied landing of fish	• Share the results of inspections on port entry, authorization or denial among coastal States and flag States as well as regional organizations such as FAO, SEAFDEC, and RPOA-IUU • SEAFDEC to serve as the regional center for sharing of data in the Southeast Asian region
	Article 16: Electronic exchange of information	• Facilitate the implementation of this Regional Cooperation, and where possible, each AMS should establish a communication mechanism that allows direct electronic exchange of information with due regard to appropriate confidentiality requirements • AMSs to cooperate for the establishment of an information-sharing mechanism by SEAFDEC to facilitate the exchange of information with existing database for this cooperation	• Develop a PSM website and database system to support the regional center for sharing of data to all AMSs • Develop an effective two-way communication • Create networks on PSMA across different levels (high level and working level) through e-mail group, social media, mobile apps, etc.
	Article 17: Training of inspectors	• AMSs to request FAO, RFMOs, ASEAN, SEAFDEC, and relevant agencies for the conduct of training of trainers (TOT) for port inspections including legal and operational aspects with emphasis on practical hands-on component • Develop a network/team among AMSs on TOT for port inspections • Consider an existing training module developed by RPOA-IUU in collaboration with the Australian Maritime on port inspections to support the TOT programs	• Conduct TOT for inspectors to support PSM implementation and development of network • SEAFDEC, FAO, and partner organizations to facilitate and support a model port as a training site • Establish network of inspectors • Establish SOPs for inspectors in the region • Develop regional guidelines for port inspection
	Article 18: Port State actions following ispection	none	• Share information among relevant organizations • Develop guidelines and inspection manual with support from FAO

that SEAFDEC and partner organizations should support and assist the AMSs to implement PSM activities through enhanced understanding of the requirements contained in the PSM, provide capacity building by engaging persons at all levels, and strengthen regional cooperation towards combating IUU fishing in the Southeast Asian region.

During the said meetings and workshops, the representatives from AMSs discussed the Port State Measures Agreement, specifically the part on "Entry into Port" and "Inspections and Follow-up Actions," and came up with the recommendations for regional cooperation on PSM implementation and the actions and needs necessary for such implementation, as shown in **Table 1**. It should also be noted that as of 2016, four Southeast Asian countries signed the instrument of accession to the PSM Agreement, namely: Indonesia, Myanmar, Philippines, and Thailand (Saraphaivanich *et al.*, 2016). Moreover, constraints/problems, challenges, and priority activities for respective AMSs were identified to address the issues on the following: operational, legal, human resources, infrastructure, information, and measures related to PSM implementation (**Table 2**).

Table 2. Constraints/problems encountered by AMSs that hinder the implementation of PSM (SEAFDEC/TD, 2017)

Constraints/ Problems	BN	KH	ID	MY	MM	PH	SG	TH	VN	Challenges	Priority activities
Support needed for becoming a Party											
• Process on becoming a party		X								none	• Technical support to the process of becoming a party
Operational											
• Lack of SOP in implementing PSM with any scale of foreign vessel	X	X	X		X	X	X		X	• Revision and reorganization of fishing port operational procedures to support PSM • Development and updating of harmonized SOPs on vessel inspection at port for guidance of all AMSs • Identification of the needs and capacity building required for staff concerned on relevant aspects PSM implementation • Difficulties in verification of vessel documentation and inspection	• Training and development of guidelines on how to come up with a robust PSM inspection and surveillance system (*e.g.* how to determine the high risk vessels and how many vessels to inspect) • Addressing specific request for training support for whole set of SOPs on vessel inspection at port • National workshops that will pool together agencies involved in PSM to develop national SOPs for interagency coordination • Updating of existing SOPs on inspection of fishing vessels and fish carriers at port to harmonize with laws which support the implementation of PSM
• Port management under different agencies leads to insufficient inter-agency cooperation for PSM implementation	X	X	X		X	X			X	• Sharing of information on vessel entry permit among concerned agencies such as DOF, Harbor Department, Custom, FMO, etc. • Establishment of ASEAN Fish Market Federation (AFMF) to promote and implement the ACDS	• Establishment of good coordination between enforcement agencies and concerned agencies • Strengthening of cooperation between government agencies and owners of private ports
Legal											
• Challenges with regards to implementation of laws and regulations	X	X	X	X			X	X	X	• Inconsistent interpretation of laws • Amendment or updating of existing regulations • Review and updating of Fishery Acts	• Analysis to identify the gaps in current legislation • FAO to provide technical assistance in reviewing legislative systems • National meeting on updating of laws and regulations to support PSM
• Challenges in interpretation of the PSM Agreement	X	X	X	X	X	X	X	X	X	• Incomprehensive interpretation of non-fisheries stakeholders of laws and regulations • Need for MOU between concerned government agencies • Need for assistance for the law enforcement officers and managers from legal officers in FAO in the correct interpretation of the provisions of PSMA • Need for assistance in the correct translation of PSM Agreement into local languages	• Review to clarify if the following are covered under the PSMA. If they are, what are expected to do and provide workshops that cover inspections in these areas? - Are land and airport of entries included in the PSMA? - Are container ships included in the PSMA? • Training on implementation of PSMA which aims to acknowledge and understand the importance of implementation of PSMA

Table 2. Constraints/problems encountered by AMSs that hinder the implementation of PSM (SEAFDEC/TD, 2017) (Cont'd)

Constraints/ Problems	BN	KH	ID	MY	MM	PH	SG	TH	VN	Challenges	Priority activities
Human Resource											
• Limited capacity of implementation due to inadequate facilities and officers concerned	X	X	X	X	X	X	X	X	X	none	• Development of capabilities across all levels (*e.g.* policy makers, port managers, inspectors, etc.) • Technical support on how to operate communication equipment
Infrastructure											
• Insufficient infrastructure for upgrading infrastructures to support PSM	X	X	X	X	X	X	X	X	X	none	• Assistance to set up or upgrade electronic databases and systems (*e.g.* eACDS, databases to record catch, VMS, MCS, GPS, AIS, and other communication systems) • Understanding on the requirements and criteria for appropriate designated ports
• Insufficient budget for upgrading infrastructures to support PSM	X	X	X	X	X	X			X	none	• Establishment of budget to set up or upgrade electronic databases and systems (*e.g.* ACDS, databases to record catch, VMS, MCS, GPS,AIS, and other communication systems) • Request for FAO to finance the development and implementation of port management system in respective AMS
Information											
• Lack of fish landing data system and management	X	X								• Encouraging "traders" to cooperate with AMSs through information and education campaigns • Sharing of information such as catch, fishing vessels, and fishing gears through sharing of experience in PSM implementation among the AMSs • Information sharing on rules and regulations for inter-agencies collaboration and implementation • Creation of a "rapid alert system" for ASEAN (through mobile application if available) • Establishment of the ACDS	• Development of SOPs for sharing of information in the Southeast Asian region • Use of Fisheries Language for Universal Exchange (FLUX) form
• List of IUU fishing vessels from RFMOs is not updated	X	X	X	X *	X	X	X	X	X		• Publication by FAO of a consolidated list of IUU fishing vessels on its website and removal of the need for countries to check various RFMO or international organization websites
• Lack of awareness among stakeholders and concerned agencies about PSM	X	X	X	X **	X	X	X	X	X		• Capacity building and awareness raising among government agencies and relevant stakeholders
• Limited traceability of some imports of fish and fishery products	X	X		X	X		X		X		• Development of the eACDS
• Lack of sharing of information among agencies where control of ports fall under different port authorities		X	X			X					• Assistance from FAO to propose the roles and responsibilities of various agencies for PSM implementation

Table 2. Constraints/problems encountered by AMSs that hinder the implementation of PSM (SEAFDEC/TD, 2017) (Cont'd)

Constraints/ Problems	BN	KH	ID	MY	MM	PH	SG	TH	VN	Challenges	Priority activities
Measures related to PSM implementation											
• Inadequate vessels registration and fishing license system management		X									• Request for FAO to finance the vessels registration and fishing license system management

** Malaysia's experience shows that RFMO's IUU vessel list may not be up-to-date*
***Malaysia sees information sharing with regards to PSM implementation, e.g. inspection report, as a challenge rather than an issue for the region*
Note: BN: Brunei Darussalam; KH: Cambodia; ID: Indonesia; MY: Malaysia; MM: Myanmar; PH: Philippines; SG: Singapore; TH: Thailand; VN: Viet Nam

Way Forward

Within its capability, SEAFDEC would continue to support the AMSs following the recommendations of regional cooperation on capacity building to support PSM Agreement implementation. SEAFDEC would organize in 2018 "The Regional Training on PSM implementation in Southeast Asia for Fishery Manager Level" in collaboration with FAO and other relevant agencies. The Training will focus on: (1) guidelines of national legal aspects, policy and institutional of Port State Measures Agreement (PSMA) implementation; (2) port inspection activities; and (3) lessons learned from Thailand on the implementation of PSM. Moreover, on-site training on PSM implementation and port inspection for inspectors in selected AMSs would also be conducted in 2018.

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Thai trawler fishing vessel

Highlighting the Importance of Inland Capture Fisheries in the Southeast Asian Region

Dina Muthmainnah, Safran Makmur, Sevi Sawestri, Aroef Hukmanan Rais, Siswanta Kaban, Freddy Supriyadi, Khairul Fatah, and *Satoshi Honda*

The Southeast Asian region is endowed with enormous areas of natural inland water resources, such as river systems, lakes, floodplains, reservoirs, dams, and wetlands, as well as a rich diversity of aquatic species. Fishing activities in these inland waters have long been practiced by rural people whose subsistence depends on the inland waters and products. These inland resources have continued to provide them food security through enhanced livelihood and improved incomes for their households. However, the sustainable development and utilization of these inland resources is crucial to sustain the socio-economic well-being of the rural folks. It was towards attaining this objective, among others, that the Inland Fishery Resources Development and Management Department (IFRDMD) of SEAFDEC was established in 2014. Specifically, IFRDMD is mandated to conduct and facilitate research projects on the sustainable development and management of inland fisheries in the Southeast Asian region.

Inland Fisheries in the Southeast Asian Region

The natural inland waters of Southeast include vast river systems and lakes, floodplains, reservoirs, dams, and wetlands. Specifically, Indonesia has more than 256 million ha of inland water bodies, followed by Myanmar with more than 82 million ha, Thailand with more than 66 million ha, and the Philippines with more than 12 million ha. Cambodia has the Tonle Sap Great Lake which could expand from 250,000 ha to more than 1.6 million ha during the wet season (Pongsri *et al*., 2015). **Fig. 1** shows the important rivers and lakes in the region that have been tapped by rural fisherfolks for many years for their subsistence.

The inland bodies of water in the region are inhabited by a rich diversity of aquatic species including an estimated 1,700 species of freshwater fish (Nam *et al*., 2009). There are more than 500 species in the Mekong Basin (Zakaria-Ismail, 1994), 290 species in the Kapuas River in Indonesia, 147 species in the Mahakam River in Indonesia, 115 species in the Baram River in Malaysia (Dudgeon, 2000), and 233 in Musi River in Indonesia (Husnah *et al*., 2008).

Inland fisheries have long been a vital component of economic security in sustaining and alleviating the poor and disadvantaged communities around the world whose subsistence depends on wetland and inland products. Fisheries in inland waters provide food security, livelihood, cultural and religious identity, recreation, and serve as a source of income for millions of people globally (Welcomme *et al*.,

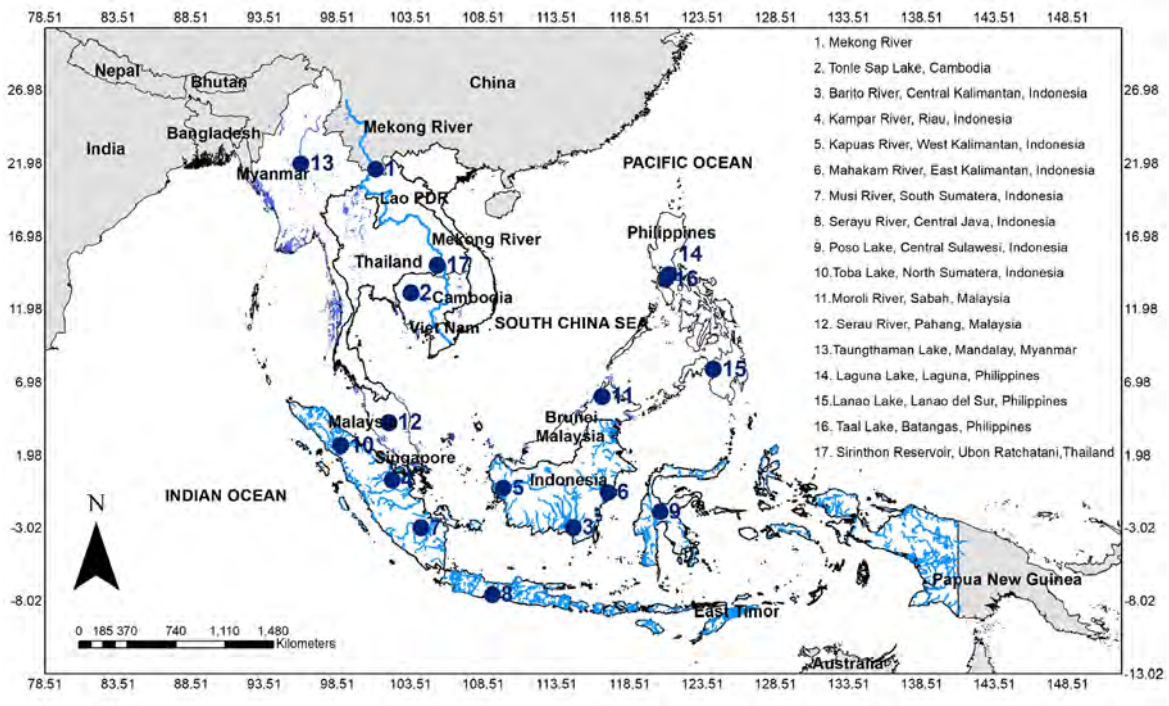

Fig. 1. Important rivers and lakes in Southeast Asia

Table 1. Production from inland capture fisheries of the Southeast Asian countries by quantity (MT) in 2014

Country	Inland capture fisheries production (MT)	Total capture fisheries production (MT)	% of inland capture fisheries production to total capture fisheries production	Total fisheries production (MT)	% of inland capture fisheries production to total fisheries production
Brunei Darussalam	-	3,186	-	3,947	-
Cambodia	505,005	625,255	80.77	745,310	67.76
Indonesia	446,509	6,413,648	6.96	20,600,772	2.17
Lao PDR	60,237	60,237	100	150,592	40
Malaysia	5,611	1,463,737	0.38	1,988,302	0.28
Myanmar	1,381,030	4,083,270	33.82	5,040,311	27.4
Philippines	211,941	2,343,813	9.04	4,681,418	4.53
Singapore	-	1,433	-	6,695	-
Thailand	209,800	1,769,546	11.86	2,667,309	7.87
Viet Nam	208,100	2,919,200	7.13	6,332,500	3.29
Total	**3,028,233**	**19,683,325**	**15.38**	**42,217,156**	**7.17**

Source: SEAFDEC (2018)

2010; Lynch *et al*., 2016). Nevertheless, inland water areas are influenced by permanent, seasonal, or intermittent occurrence of flooded conditions. During the wet season, the lowland swamps become a productive fishing ground (Muthmainnah and Gaffar, 2010) where inland capture fisheries and related activities could harvest high volumes of fish. Fishing activities in these areas usually start during the beginning of the rainy season when fish migrate from the main river either for feeding or spawning and finish during the middle of dry season when the fish are going back to the main river.

As shown in the fisheries statistical data on inland capture fisheries, the region's total production from inland capture fisheries in 2014 (**Table 1**) was 3,028,233 metric tons (MT), accounting for approximately 15% of the region's total capture fisheries production or 7% of the region's total fisheries production. The top producer, Myanmar accounted for 33.8% of the country's total production from capture fisheries, 27.3% of the country's total fisheries production, and 3.3% of the region's total fisheries production. As the second highest producer, Cambodia reported production volume of 505,005 MT that represented 80.8% of the country's production from capture fisheries, 67.7% of the country's total fisheries production, and 1.2% of the region's total fisheries production.

It should be noted however, that the abovementioned information could be under reported due to the inadequacy of information gathered on inland capture fisheries. An ongoing regional effort has been underway to improve the compilation of fisheries data from inland capture fisheries of Southeast Asia. This could lead to the establishment of the real situation of the inland capture fisheries in the region.

Meanwhile, IFRDMD has been promoting and raising awareness on the sustainable management of inland fisheries in Southeast Asia through the five-year project "Promotion of Responsible Utilization of Inland Fisheries in Southeast Asia (2015-2019)." The specific objectives of the project are to: 1) review the activities and methodologies on promoting inland fisheries in the ASEAN Member States (AMSs); 2) promote effective inland fisheries management measures in the AMSs; and 3) to study and develop habitat conservation/resources enhancement measures suitable for the region.

As one of the activities of the project, the workshop "Review of Activities and Methodologies for Promotion on Inland Fisheries" was organized by IFRDMD in August 2016 in Palembang, Indonesia. Attended by representatives from

Table 2. Some aspects of inland fisheries in the Southeast Asian countries

Country	Data collection system			Members of Fisheries Management Committee	Side jobs of fishers
	Start	Interval	Responsible agency		
Cambodia	1983	monthly	National government and MRC	Fishers	Farming, small-business ventures
Indonesia	1974	yearly	National and local government	Government, fishers, NGO	Rice and non-rice farming, fish culture, cattle farming, rubber/ palm plantation, non-timber forest product collection, horticulture
Lao PDR	2003	yearly	National government	Government, fishers, NGO	Rice cultivation, gardening
Malaysia	1985	yearly	National government	Fishers	Farming, rubber tapping, gardening
Myanmar	N.A.	yearly	Local government	NGO	Agriculture
Philippines	1960	yearly	National government	Fishers	Farming, livestock raising, peddling goods, caretaking, construction works
Thailand	1969	yearly	National government	Fishers, government, lecturers	Farming, contract services
Viet Nam	1946	monthly	National government	Fishers committee	Cultivating, animal husbandry, small business

Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Thailand, and Viet Nam, the workshop was also attended by scientists from the Mekong River Commission (MRC), Japan International Research Centre for Agricultural Sciences (JIRCAS), Ubon Ratchathani University (UBP) of Thailand, Bogor Agricultural University (IPB) of Indonesia as well as officers and staff of the SEAFDEC Secretariat and Training Department. The workshop discussed the current status of inland fisheries in the Southeast Asian region as well as established the precise methods of collecting data on inland fisheries, particularly on catch statistics, fishing gears, management measures, and the livelihood opportunities in inland fisheries.

From 2015 to 2017, IFRDMDs conducted surveys in the Southeast Asian countries to compile the basic information on inland capture fisheries (**Table 2**). The results indicated that the Philippines and Thailand started collecting data as early as 1960s, while Lao PDR started in 2003. All countries update their inland fisheries data annually, except for Cambodia which is done monthly. While the local government of Myanmar is responsible for data collection on inland fisheries, it is the national government for the rest of the Southeast Asian countries. The findings also indicate that since inland capture fisheries is seasonal, most inland fishers are involved in several side-jobs to augment their incomes.

Issues and Constraints in Inland Fisheries in Southeast Asia

Inland water resources are being degraded and many are almost lost, mainly as a result of destructive human activities. Changes on the aquatic environment brought about by fishing and non-fishing activities disrupt the sustainability of the inland water resources. Destructive fishing practices such as using poisonous substances and electric shock damage the whole fish communities while inadequate management of aquaculture negatively impacts on the water quality. Modification of water bodies (damming or dredging) destroys the spawning ground, changes the fish migration pattern, and harms fish feed organisms. Competition on the utilization of the freshwater resources among several sectors (*e.g.* development projects) also damages the aquatic ecosystem.

Furthermore, the real situation of inland fisheries in the Southeast Asian region could not be established in view of the various issues and constraints confronting the compilation of data that include: 1) inadequacy of data on inland fisheries production; 2) ineffectiveness of the methodologies used in data collection; 3) varying data collection and reporting systems among the countries; and 4) shortage of human and institutional resources. Reliable and comprehensive data are important to guide the policymakers and the stakeholders in the management of inland fisheries. However, inland capture fisheries comprise a large number of subsistent fishers who are mostly engaged in part-time fishing activities, with their catch going to various channels, *i.e.* used for household consumption, sold in local markets, or exported to markets within the region. Also, the resources could be freely accessed, and the production is multispecies which could be landed anywhere without proper recording. In the midst of these constraints, the data are fragmented and discontinuous, making the collection of catch statistics difficult to undertake.

Recommendations and Way Forward

The primary purpose of fisheries management is to establish the appropriate system management rules based on defined objectives, and a mix of management means to implement regulations, which are put in place by a system of monitoring, control, and surveillance (Wilson *et al*., 2003). To sustain the inland fishery resources, there is a need to develop an integrated management that involves stakeholders in making management decisions. Prior to that, studies on co-management and rights-based fisheries management applicable to inland fisheries in the region are important to reach and share the common understanding on the issues and problems on the implementation process. Appropriate management measures could include fish catch size limitation, regulations on fishing gears, open/close fishing season, establishment of conservation zones, and studies on the biology of the target species as well as capacity building for the people who involved in handling these issues.

Concerns on the sustainable development and management of inland fisheries could also be addressed if the real-time basic information on the fisheries inland water bodies is in place. It is towards this end that the project being carried out by IFRDMD is targeting. Moreover, intensive information sharing and workshops among AMSs are essential to promote effective inland fisheries co-management system in the region. This is being promoted by IFRDMD through its planned activities that include a workshop to develop guidelines for effective inland fisheries management in the region to be participated by representatives from the AMSs. The workshop would also aim to formulate appropriate management measures on inland fisheries applicable to each area and country, after which the fisheries departments of respective countries will be consulted to assess the feasibility of such management measures.

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Promoting Community-based Resources Management:
a Case Study in Nam Oon Dam, Sakon Nakhon Province, Thailand

Thanyalak Suasi, Sumitra Ruangsivakul, Jariya Sornkliang, and *Rattana Tiaye*

The SEAFDEC Training Department (SEAFDEC/TD) has been implementing the six-year project "Enhancing the Compilation and Utilization of Fishery Statistics and Information for Sustainable Development and Management of Fisheries in the Southeast Asian Region: Facilitating Activities on Gathering Fisheries Information through Introduction of Community-based Resources Management/Co-management" since 2013. Supported by the Japanese Trust Fund (JTF), the project necessitates the improvement of the compilation of fisheries data to reflect the importance of small-scale coastal and inland fisheries, and which could be used as a basis for fisheries planning and management. The project has the ultimate objective of supporting the ASEAN Member States (AMSs) through the assessment of problems and constraints in fisheries data collection in small-scale coastal and inland fisheries at national levels. In the process, the key issues in fisheries data collection could be identified and addressed by the countries through regional workshops and on-site trainings on the concept of community-based resources management (CBRM) that could be organized by SEAFDEC/TD at provincial levels in respective AMSs. The project also intends to provide technical assistance to fisheries officers of the AMSs in selected sites to enable them to properly collect and analyze the information gathered from fisheries communities, for policy formulation, and later on, for the development of appropriate CBRM plans for small-scale coastal and inland fisheries. To set off the project, Thailand was chosen as a project pilot site, more particularly the Nam Oon Dam in Sakon Nakhon Province, where the on-site training course on Practical Approach for Enhancing Co-management in Inland Fisheries organized by SEAFDEC/TD in 2013, provided a clearer and detailed perspective on the concept and methodologies on CBRM, and enhanced the skills of the stakeholders in establishing fisheries organizations.

Small-scale coastal and inland fisheries are important source of protein and generate income to support local fishing communities. Small-scale fisheries are usually operated in coastal marine waters less than 3 kilometers from the shoreline, brackishwater lagoons, as well as in freshwater lakes, rivers, and reservoirs (Staples *et al.*, 2004). Small-scale fishing can be done with or without boats and uses gillnet, trap, hook and line, and other simple fishing gears (Kristin and Dearden, 2005), while the catch is usually for household consumption or sold in the local markets.

The open access in fisheries wherein everyone has the right to catch fish and the fishing ground is open to all (OECD, 2007) has however led to overfishing and decline of the fishery resources. This has also greatly affected the small-scale fishers who utilize the fishery resources for livelihood and in the end, could even lead them to be engaged in illegal fishing. While poor fisheries management due to lack of management oversight, laws, and regulations has long been a problem in the fishing industry (WWF, 2018), such problems in fisheries could be addressed through the promotion of systematic fisheries management.

Community-based resources management (CBRM) or co-management is a fisheries management approach where the resource users and local stakeholders participate in the planning and formulating the regulations that the communities should comply with. CBRM could be facilitated by the local government or other organizations (Senyk, 2005). Basic small-scale fisheries information is necessary for establishing the CBRM for sustainable fisheries. However, in the Southeast Asian region, fisheries statistics and information on coastal and inland fisheries are generally inadequate due to its multi-species nature and large number of small-scale fishers. It is therefore necessary to improve the methodologies in data collection for effective establishment of the appropriate fisheries management plans.

CBRM: Case Study in Nam Oon Dam

In 2014, SEAFDEC/TD collaborated with the Department of Fisheries (DOF) of Thailand to implement a CBRM project in Nam Oon Dam in Pangkhon District, Sakon Nakhon Province in northeast Thailand (**Fig. 1**). Nam Oon Dam was established in 1981 with water volume of about 520 million m^3, used to supply the water requirements of the agriculture sector of the Province. Nam Oon Dam was proposed by the DOF Thailand as the pilot site of the project because many

Fig. 1. Location of Nam Oon Dam in Pangkhon District, Sakon Nakhon Province, Thailand *(Source: Google maps)*

Fig. 2. Location of the sixteen communities involved in the SEAFDEC/TD project in Nam Oon Dam *(Source: Google maps)*

outsiders who are not concerned about the need to conserve the fishery resources, fish in Nam Oon Dam.

In addition, illegal fishing has been reported to occur in the Dam, where these illegal fishers use the mechanical giant lift net, a cone shaped stationary fishing gear submerged at a certain depth with the opening facing upwards. Moreover, the local government has deemed it necessary to define the conservation zone in Nam Oon Dam for the sustainability of the fishery resources in the Dam.

Sixteen communities around Nam Oon Dam (**Fig. 2**), whose members have recognized the need to conserve the fishery resources in the Dam, have been involved in the project. At the onset of the project implementation, a baseline survey was conducted in July 2014 to obtain understanding on the condition of the communities as well as their existing problems by interviewing 139 fishers around Nam Oon Dam. The results showed that most fishers engaged in fisheries were also engaged in agriculture (paddy field, rubber tree, cassava, among others). The main fishing gears used include gill net, hook and line, and fish trap. The major species caught were the Siamese mud carp, Indian river barb, and common silver barb. Most of the catch is intended for household consumption or sold in the local markets.

Moreover, the inland fisheries management committee for Nam Oon Dam was established while the committee members were selected and trained to build their awareness on the importance of CBRM and the need to promote the conservation of fishery resources in Nam Oon Dam. The committee consists of two representatives from each community together with government fisheries officers. The committee has been responsible in developing the fisheries management plan for Nam Oon Dam.

A workshop for the inland fisheries management committee of Nam Oon Dam was organized in November 2014 to define the fisheries management measures and enhance their knowledge on inland fisheries management and the fisheries law. The workshop was also used as an avenue for the development of regulations on fishing gears and methods, as well on fishing grounds and conservation area, and closed season. As a result of the workshop, some fishing gears such as the giant lift net, use of air compressor for diving fishing gun as well as light luring for collecting juvenile fish, had been banned in the Dam. The fishing ground and conservation zone had been increased and clearly defined. On the other hand, long line fishing has been allowed during closed season, and fishing is allowed on the 10th, 20th, and 30th day of each month. The closed season is imposed during the fish spawning season from 16 April to 15 August.

The fisheries management measures developed by the committee were announced through signboards that were put up in the communities around Nam Oon Dam (**Fig. 3**), considering that signboards are effective communication materials where the communities could easily perceive the information displayed. Measuring 1.2 m× 2.4 m, the signboards contain the map of Nam Oon Dam, closed season period, the allowed date for fishing, prohibited fishing gears, conservation zone, and fishing gears allowed to be used in open and closed season. Local meetings were regularly organized to explain the fisheries management measures that were displayed in the signboards that have been set up by the management committee with the involvement of the community members.

Fig. 3. Signboards put up in the communities around Nam Oon Dam

The appropriateness of fisheries management measures was monitored through the satisfaction surveys that were conducted in November 2015. Questionnaires were used to interview 123 fishers about the status of fishery resources after the closed season, while the performance of DOF, Thailand in implementing the CBRM project was also rated. The results showed that more than 80% of interviewed fishers were satisfied with the CBRM approach adopted in Nam Oon Dam.

For the continued monitoring of the status of the fishery resources, a local meeting was organized in February 2015 to train the volunteer fishers on how to record the fish catch

Fig. 4. Measuring the body length and weight of fish samples by a volunteer fisher in Nam Oon Dam

in the logbook developed by SEAFDEC/TD. The resource assessment and data collection were initiated in March 2017 in four selected communities, namely: Ban Dong Khampho, Ban Kudtakap, Ban Klang, and Ban Nachuak. The body length and weight of each fish sample were measured (**Fig. 4**). The analyzed catch data indicating the current status of fishery resources in Nam Oon Dam would be shared to the fishers for feedback and to be used as scientific reference for the development of the fisheries management measures.

Based on the agreement among the communities for habitat restoration and protection of fishery resources, the conservation zone in Nam Oon Dam was designated. Covering an area of about 1,028,800 m^2 and located between Ban Dong Khampho and Ban Nachuak, the conservation zone would be marked using the 15 buoys provided by SEAFDEC/TD, which were installed in May 2016 (**Fig. 5**). These bouys would not only provide markers for the conservation zone but also indicate the border between the two communities.

Fig. 5. Installation of buoys to mark the area of the conservation zone and the border between Ban Dong Khampho and Ban Nachuak in Nam Oon Dam

Key Findings and Way Forward

During the implementation of the project in Nam Oon Dam starting in 2014, it was found that one of the important factors in implementing CBRM is the strong collaboration between the resource users and government fisheries officers, which could facilitate the development and effective implementation of the desired fisheries management measures. As a result, illegal fishing which has been a common problem in Nam Oon Dam, could be eventually decreased. In addition, recording of fish data in logbook by volunteer fishers was the most cost effective approach, as the active participation of the fishing community in all activities could create in them a sense of belongingness and responsibility, and raise their awareness on the need to conserve the fishery resources. As envisioned, the fisheries management measures developed from this case study, would be improved and extended to other fishing communities not only in Thailand but also in other Southeast Asian countries. Results of the research works on CBRM in coastal and inland fisheries would also be used to identify the most effective fisheries management model that is applicable to small-scale fisheries in the Southeast Asian region. Meanwhile, for the project site in Thailand, activities in the future would include a workshop in 2018 to review the effects of the fisheries management measures in Nam Oon Dam. Collection of catch data will continue for resource assessment, the results of which would be used to develop a research paper that could serve as basis for the promotion of CBRM in other sites in the Southeast Asian region.

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Advocating Preventive Measures that Inhibit Early Mortality Syndrome in Shrimps

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Early Mortality Syndrome (EMS) is a generic name used to describe the observed mortality occurring within the first 30 days of stocking shrimp post larvae (PL) in ponds. The aquaculture species reported to be affected by EMS are *Penaeus monodon*, *P. vannamei* and *P. chinensis*, of which *P. monodon* is the most susceptible. EMS has been reported in China (2009), Viet Nam (2010), Malaysia and Borneo (2011), and Thailand (2012). EMS could have been present in the Philippines as early as 2007 but this was not given attention then. Fish farmers in the Philippines observed that mortalities that occur as early as one week after stocking *P. monodon* PL in ponds or within two months of stocking were not due to the whitespot syndrome virus (WSSV). Hence, the farmers call it the two-month mortality syndrome (Tendencia *et al*., 2014). EMS is associated with WSSV, microsporidian infestation, *Vibrio* infection, and chemical contamination (Flegel, 2016; FAO, 2013). Affected shrimps have pale to whitish hepatopancreas with black spots or streaks, rigid and hard to squash. Histopathology of the hepatopancreas of shrimp samples from EMS cases showed massive necrosis and sloughing or shedding of the epithelial cells. EMS characterised by these specific histopathological changes in the hepatopancreas is called Acute Hepatopancreatic Necrosis Disease (AHPND). Incidence of AHPND has been recently reported in China, India, Malaysia, Mexico, Philippines, Thailand, and Viet Nam.

EMS/AHPND is due to a bacterium, *Vibrio parahaemolyticus* (VPAHPND) that colonizes the shrimp stomach where it produces the toxin responsible for the histopathological changes in the hepatopancreas. *V. parahaemolyticus* is ubiquitous and ever-present in marine and brackishwater environments, and thus can be present in the cultured shrimp,

Healthy *P. monodon* harvested from a local fishpond in the Philippines

Fish health officer preparing samples for polymerase chain reaction (PCR) analysis

water, sediments, and associated organisms of the culture pond. VPAHPND have transferrable plasmid or jumping genes that carry the PirA/B toxins (Kondo *et al*., 2015). In this case, the jumping genes that carry the toxin, leap into other bacteria in the environment resulting in the variation of the *V. parahaemolyticus* that has been isolated from shrimps experiencing an AHPND outbreak, as well as in the isolation of *V. harveyi*-like, *V. Owensii*, and *V. campbelii* in EMS/AHPND cases (Kondo *et al*., 2015; Liu *et al*., 2015; Dong *et al*., 2017).

Incidence of AHPND and WSSV in Shrimp Aquaculture

Between 2013 and 2014, production volumes of *P. vannamei* and *P. monodon* in the Philippines decreased due to disease outbreaks primarily in Luzon and the Visayas areas (Bureau of Agricultural Statistics, 2014), which was suspected to have been caused by AHPND. Samples from shrimp farms were examined for the toxin-producing strain of *V. parahaemolyticus* because of the AHPND-like symptoms occurring in shrimps after 56-94 days of culture. Analysis using the IQ2000 AHPND/EMS Toxin 1 PCR test generated 218 bp and 432 bp amplicons, confirmative of the toxin-producing strain of *V. parahaemolyticus* among shrimps taken from eight of the nine ponds sampled. In *P. monodon*, histology revealed a massive sloughing of undifferentiated cells of the hepatopancreatic tubule epithelium in the absence of basophilic bacterial cells. The tests using the Polymerase Chain Reaction (PCR) generated the two amplicons confirmatory for AHPND among shrimps sampled from five of seven ponds, confirming the

(Top): *P. monodon* with AHPND. Note the whitish color of the hepatopancreas; (bottom): *P. monodon* infected with WSSV. Note the white spots on the abdominal segments and carapace

presence of AHPND in *P. vannamei* and *P. monodon*, and suggesting that the disease can also impact late-stage juvenile shrimps (dela Peña *et al*., 2015).

Starting in 2013, AHPND was already included in the NACA/FAO Quarterly Aquatic Animal Disease (QAAD) Reporting System under the "non-OIE listed diseases" category for crustaceans. A year later, a request was submitted to the World Organization for Animal Health (OIE) to include AHPND in the List of Notifiable Diseases. However, the OIE Aquatic Animal Health Standards Commission (AAHSC) did not endorse the listing, and AHPND was not included in the OIE List until January 2016.

On the other hand, WSSV has already been included in the OIE List since 1997, and as of 2018, both AHPND and WSSV have been included in the OIE listed diseases for crustaceans. It should be noted that diseases that have not been reported for two consecutive years are delisted from the OIE List.

Cross sectional studies have been carried out by several researchers, where the results identified the factors that may increase or reduce the risk of AHPND and WSSV. These are related to the pond characteristics, season, pond preparation protocol, water management, culture practices, farm inputs, and water parameters (Bondad-Reantaso, 2016; FAO, 2013; Tendencia *et al*., 2011; Tendencia *et al*., 2010a; Tendencia *et al*., 2010b). Listed in **Table 1** are the factors that increase the risks of AHPND and WSSV in *Penaeus monodon*, while the factors reducing the risks are listed in **Table 2**.

Preventive Measures for Mitigating the Incidence of AHPND and WSSV in Shrimp Aquaculture

The Japanese Trust Fund (JTF) has been providing financial assistance to AQD to carry out research studies towards the development and/or improvement of preventive measures against AHPND and WSSV. The studies include identification of disease risks and protective factors, while tank-based and pond studies were also carried out to mitigate the effects of AHPND and WSSV in cultured *P. monodon*.

These JTF-funded studies, include: 1) Epidemiology of the White Spot Syndrome Virus (WSSV) in Different Shrimp (*P. monodon*) Culture Techniques in the Philippines; 2) Establishment of Management Technology for Disease Tolerant and Sustainable Aquaculture Environment; 3) Epidemiology of the Early Mortality Syndrome in *P. monodon*; and 4) Responsible Aquaculture through Aquasilviculture.

Table 1. Factors that increase the risks of AHPND and WSSV in *Penaeus monodon*

	AHPND	WSSV
Pond description	• Bigger pond size • Near AHPND-affected ponds	• Near other pond
Season	• Warm season	• Cold season
Pond preparation	• Sludge removal • Pond drying • Use of saponin	• Sludge removal
Water management	• Low water turnover	• Sharing of water source with other pond • Same receiving and water source • Tidal
Culture method	• Source of PL • High stocking density • Intensive system • Semi-closed system	• Source of PL • High stocking density
Feed and other inputs	• Use of antibiotics, vitamins, minerals • Live feeds • Overfeeding • Fertilizer, molasses use resulting in high nutrient levels	• Feeding with live mollusks
Water parameters	• Temperature fluctuations • pH 8.5- 8.8 • Low salinity	• Temperature fluctuation • pH fluctuation • Low salinity

Table 2. Factors that could reduce the risks of AHPND and WSSV in *Penaeus monodon*

	AHPND	WSSV
Pond description	• Older pond • With reservoir	
Months/Season	• Cold	• Warm
Pond preparation	• Chlorination and liming	
Water management	• Use of aged seawater, held > 35 days before use	
Culture method	• Greenwater, • Biofloc • Use of probiotics	• Greenwater • Presence of mangrove
Feed and other inputs	• Reduced/controlled feeding	• Abundance of natural food
Water parameters	• Low salinity	

Aside from the epidemiological and disease prevention studies, the JTF also funded studies on shrimp diseases surveillance and detection methods, and in the recently-completed study "Monitoring and Surveillance of Transboundary Pathogens in Cultured Shrimps and Freshwater Prawn," *P. monodon* and *P. vannamei* were tested for viral diseases using PCR on WSSV, the Infectious Hypodermal and Haematopoietic Necrosis Virus (IHHNV), Taura syndrome virus (TSV), and the Infectious Myonecrosis Virus (IMNV). The results showed that only IHHNV and WSSV affect shrimps cultured in the Philippines, while the other two viral diseases, *i.e.* TSV and IMNV are presumed exotic to the country. The ongoing study "Development and Acceleration of Rapid and Effective Fish and Shrimp Health Management" attempts to determine the (viral DNA/RNA copies in an organism that can result in an infection) threshold infection levels for WSSV and other pathogens such as VPAHPND using q-PCR.

Despite the identification of AHPND and WSSV risk and protective factors, EMS continues to bring havoc to the shrimp industry as evidenced by their inclusion in the OIE List of Notifiable Diseases in 2018. This calls for the development and/or improvement as well as intensified promotion of preventive measures against EMS, which include strict and proper implementation of existing biosecurity and good aquaculture practices (GAPs). Ecosystem approach to aquaculture to prevent diseases should be practiced by small-scale shrimp farmers, whose ponds are located very close to each other, sharing the same water source, and lacking funds to rehabilitate their ponds or to purchase and use probiotics.

Dead shrimp in ponds: mortality is due to WSSV

Promotion of Good Aquaculture Practices

Implementation of GAPs begins with site selection. It is generally perceived that most ponds had already been in operation, therefore, the identified risk factors related to pond site selection, *i.e.* near to other ponds and big pond size could not be avoided. Proper pond preparation is the next step to avoid EMS occurrence (Tendencia and Coniza, 2015). One of the identified risk factors to both AHPND and WSSV is sludge removal. Proper sludge removal is one of the aspects in GAPs. However, this is not properly followed by most shrimp farmers when depositing the sludge on the pond dike. Sludge removed from the pond bottom usually contains toxic substances, high organic load, and microorganisms that could be washed back into the culture pond. Thus, sludge removed from pond bottom should be placed far from the pond site. After sludge removal, the pond bottom should be ploughed and cracked dry to oxidize the remaining organic matter and other toxic substances, and then limed to kill harmful microorganisms. Liming increases the pH of wet soil to 11, to efficiently kill harmful microorganisms including viruses, and shift the dominance of vibrios from green to yellow colonies. The yellow vibrios usually have probiotic effect while the green ones are pathogenic. Furthermore, lime application to soil with pH 11 can kill unwanted species (Coniza and Tendencia, 2014). Most small-scale shrimp farmers with bigger ponds could not totally dry their ponds due to uneven pond bottom and do not apply lime due to budgetary constraints. Moreover, good plankton growth should be fostered through the application of fertilizers. Plankton not only improves water quality but also enhances the shrimp immune system making them more resistant to EMS.

Application of lime in shrimp ponds

Good water management is another aspect of the GAPs. The water used to fill the culture pond should be filtered to prevent entry of unwanted species that could be disease carriers. The risk brought by sharing water source with other ponds, and having the same water receiving and source could be mitigated by providing reservoir and settling ponds (Tendencia *et al*., 2011). The reservoir can be stocked with high saline tilapia or other finfishes such as siganids or rabbitfish. After >14 days, the water from the reservoir with finfish which is known as greenwater system, can be used to culture shrimp (Tendencia, 2018a; Tendencia *et al*., 2015). The fish faeces in a greenwater system would also serve as fertilizer to promote the growth of algae, as previously mentioned, to help improve the water quality and shrimps' resistance to diseases like EMS.

Furthermore, algae and fish mucus also have antimicrobial properties. If the reservoir is not stocked with finfish, the water could be stocked in the reservoir for at least 28 days to make it microbiologically mature before using it to fill the shrimp culture pond. Nevertheless, the effluents from shrimp ponds should be emptied into a settling pond with mollusks, macroalgae or mangroves before draining the water into the sea after > 14 days (Tendencia, 2018b; Tendencia *et al*., 2012). Mollusks, macroalgae, and mangroves have the ability to remove nutrients from the effluents aside from having anti-microbial properties.

Adoption of semi-intensive/intensive culture system

The pond is ready for stocking when there is good growth of natural food. Shrimp PL for stocking should be uniform in size and previously analysed to be AHPND and WSSV free. High stocking densities should be avoided as these would easily pollute the pond and stress the shrimps making them susceptible to diseases like EMS. In addition to causing stress, high stocking density increases the frequency of contact among individual stock, leading to increased rates of disease transmission and infection. On-farm nursery rearing of shrimp PL inside hapa nets for 15-20 days will help the shrimps adapt to the new environment where they are exposed to a lot of micro-organisms and a range of environmental parameters as opposed to the controlled condition in hatchery tanks (Rodriguez *et al*., 1993).

During culture, water depth should be maintained to at least 80 cm in the shallowest part of the pond, but > 100 cm is better. Transparent water should be avoided, as transparency is a gauge to determine abundance of not only natural food but also of suspended solids. Water exchange should be minimized and should be done during critical period only to avoid the EMS risk factors from occurring, such as fluctuations in pH, temperature, and salinity. Agricultural lime can be applied after water exchange and rain, and paddle wheels should be used to avoid low dissolved oxygen (DO) level. Feeding trays should be installed to monitor feed consumption, while feed should be based on the demand of the shrimp to avoid uneaten feeds that can pollute the environment and increase the organic matter contents of the pond soil, because pathogens causing EMS thrive well in an environment with high organic load. Aside from the high organic load in the soil, uneaten feed can lead to increased nitrogen in the pond water to levels detrimental to the shrimp. If live food such as trash fish and mollusk are used as feed to the shrimp, these should be pathogen free.

Use of paddle wheel aerators in shrimp pond

Optimizing the use of biosecurity measures

Although biosecurity is one of the protective measures that farmers could rely on to prevent disease occurrence by

excluding pathogens and carrier organisms from the culture environment, this did not prevent WSSV outbreak in a cross sectional study by Tendencia *et al*. (2011). This may be because in many cases biosecurity measures, do not achieve their purpose. Nevertheless, optimization of the biosecurity measures in ponds is still necessary. An effective biosecurity program requires careful planning and strict implementation of the measures. Pathogen exclusion in shrimp farm needs technical knowledge and experience in order to identify the various pathways, as pathogen would take all possible ways to infect a healthy population. Even assuming that the shrimp PL being used for culture are specific pathogen free (SPF), still there are generally three major pathways which a pathogen could gain access into the culture facility, such as through land-based carriers (*e.g.* crabs, rodents, and other mammals including humans); water-borne carriers (*e.g.* wild shrimps, swimming crabs, and other wild crustaceans in the surrounding waters); and air-borne carriers (*e.g.* aquatic birds).

Constructing a biosecurity fence to enclose the culture facility could be one of the major ways of preventing land-based carriers from gaining access into the grow-out facility, as frogs, rodents, cats, dogs could be prevented entry, and the spread of viral materials by low flying birds hunting for food at night, could also be avoided. The fence would also serve as a barrier to prevent contaminated persons or materials from getting into the culture areas. Only a single access point for entry and exit should therefore be designated and provided with decontamination facilities. In this way, production personnel and equipment should be properly disinfected and sanitized before entering the fenced grow-out facility. Bigger areas may have to be divided into culture zones, so that personnel involved in each zone have to wear shirts of different colors to identify them with their respective culture zones and are not allowed to go to other zones. Individuals not involved in the culture process should be strongly discouraged from entering the "clean zone" (the area after decontamination outside of the culture zones). Persons wearing anything wet or carrying any wet item(s) into the farm should be strictly denied entry. A crab fence 30 cm in height constructed along the dikes would prevent the entry of wild crabs that bring pathogens into the ponds. Any form of crustacean-based food whether cooked and especially raw should be strictly prohibited in the culture facility.

Adoption of the ecosystem approach to management in extensive culture systems

Small-scale shrimp farmers usually have big ponds (> 1.0 ha), located close to each other, and do not have the provisions for reservoirs or settling ponds, but having the same water receiving and source, and sharing water source with other ponds. These farms are more at risk to EMS than those into semi-intensive/intensive system that are usually corporate-owned and have the financial capacity to implement innovations. One approach in establishing the preventive measures against EMS in this type of system is through the ecosystem approach to aquaculture management (EAAM), an approach which is based on the FAO Code of Conduct for Responsible Fisheries, and is especially relevant when aquaculture takes place in common properties where water resources are shared. The first step in the EAAM to prevent diseases is to identify the aquaculture management area (AMA) consisting of the aquaculture zone for aquaculture management or selected farms/ponds within the zone that are grouped/clustered, and choose the design of aquaculture management to be practiced. Aquaculture zones could include a hydrological system that encompasses part of or an entire catchment area from the source to water body that will receive the farm effluents including those from pond sites that consist of different clusters of ponds/farms (FAO and World Bank, 2015).

Since all farms in the AMA contribute to nutrient loading as well as to the possible spread of diseases and other impacts of aquaculture, a form of collective management would be necessary, but should be agreed upon by the aquaculture operators, especially with respect to certain management practices that could minimize the overall impact of their collective culture activities. Farms/ponds in the AMA should therefore establish their respective management plans but the aquaculture activities should be implemented simultaneously. This means that stocking the ponds should be done at the same time using shrimp PL obtained from the same source, water change is synchronized, the same feed and feeding management is adopted, and harvesting of the stock should be done at the same time. This process protects the environment and reduces the risk of EMS. Execution of the plan is monitored to allow for review and adoption of possible changes or adjustments, especially in the biosecurity, social, and environmental measures, as deemed necessary.

Intensified adoption of other established preventive measures

Brackishwater deepwell would be an ideal source of culture water as this is truly pathogen-free. In case surface water needs to be used for culture, a reservoir is needed to hold the water for conditioning prior to its use in the pond. Water needs to pass through fine-mesh filters before being allowed to flow into the ponds to prevent the entry of water-borne carriers. Each pond will have its own set of culture paraphernalia, *e.g.* secchi disk, feeding boats, sampling bottles, to avoid contamination. Field equipment used in monitoring pond water parameters should be appropriately disinfected between usages.

Birds have become a major concern in shrimp farming because of their ability to move from farm to farm, and have the potential to spread viral particles much faster because of their

habit of feeding on weak and lethargic shrimps from nearby ponds that have been compromised with diseases. Bird-scare devices, especially UV resistant nets and lines have proven effective in preventing the entry of birds into the ponds to hunt for food. Trees that act as bird shelters inside the grow-out facility should be removed. Other unnecessary vertical structures inside the farm that birds could use to roost should be minimized or removed.

The use of high-density polyethylene (HDPE) liners has also allowed for faster crop turnovers and lesser dike maintenance between production cycles. HDPE-lined ponds have lesser amount of sludge accumulation in the pond bottom because of the protection it offers against scouring of the pond bottom and dikes. As such there will be less substrate material for pathogen growth in the pond bottom resulting in a better pond culture environment for the shrimps. Nonetheless, for the effective implementation of this program, a regular audit of existing biosecurity protocols should be performed independently every week (or as often as practically necessary) to prevent any breach in the farm's defence against diseases. This will help assure that all biosecurity protocols and procedures are properly followed and implemented.

Conclusion and Way Forward

Overall, regular monitoring of water parameters, pond bottom, and cultured shrimps should be implemented. Shrimp should be observed closely for abnormality in their swimming behavior, eating habit, and appearance. One of the first signs of disease is loss of appetite and abnormal swimming behavior. Weak shrimps should be immediately removed while shrimp samples should be sent to a diagnostic laboratory for early detection of disease so that preventive or control measures can be promptly implemented. Season of stocking shrimp PL in ponds is a risk factor for both AHPND and WSSV. Ironically, while the cold months reduce the risk due to AHPND, it increases the risk due to WSSV. To minimize mortality due to EMS, the quality of PL for stocking, as well as the quality of water and pond bottom conditions which are very crucial, should therefore be in good conditions.

Prevalent, emerging and re-emerging diseases like EMS will continue to exist. The techniques developed, improved and promoted through the JTF-funded projects will help farmers from SEAFDEC Member Countries that are into semi-intensive/intensive shrimp culture, to prevent or mitigate the effects of diseases. Farms practicing the developed techniques will have high economic returns and have high chances of getting a Certification provided that the other requirements like documentation are complied with. Promotion and proper implementation of the techniques should be strengthened. Demonstration ponds that strictly follow the GAPs and biosecurity measures should be identified and designated, to convince the other farmers that disease problems in aquaculture could be overcome through the implementation of proper farm management. The success of these demonstration ponds could then be disseminated to the stakeholders through lectures, on-farm trainings, and enhanced information, education and communication campaigns.

Small-scale farmers comprise the majority of the stakeholders, and usually have low production due to the existing set-up: adjacent to each other, no reservoir nor settling ponds, having the same water receiving and source, and sharing the same water source with the other ponds. Although the situation looks bleak for improved production and export of their shrimp produce, there is still hope for improvement provided the adoption of the EAAM concept is seriously taken up. The assistance of organizations, like FAO could also be engaged, as their expertise and with the collective effort of stakeholders, the aquaculture area management of clustered ponds could be promoted, as this concept provides the bright future in shrimp production and leads to improved performance of the ponds and enhanced eligibility for Certification as a group. At the initial state however, the EAAM concept could be applied in one area only to show to small-scale farmers that it is efficient, but the success of EAAM in an AMA would encourage the other farmers to form clusters.

Aquaculture recirculating system and use of constructed wetlands could also improve shrimp production and livelihood of small-scale farmers. Projects on the identification of aquatic organisms that have high economic value and the ability to improve water quality of pond effluent that can be used in the aquaculture recirculating system and constructed wetlands are worthy of funding. Both aquaculture recirculating system and constructed wetlands can be integrated in the culture of shrimp using semi-intensive/intensive systems and in the AMA.

The success of any form of farm management, such as AMA management, EAAM and other management schemes mentioned above, and the promotion of any developed technique would depend on the cooperation among stakeholders, and on the awareness through capacity building of the key industry players. This will pave the way to the rise of the *P. monodon* industry to the glory where it used to be.

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Utilizing Alternative Ingredients in Aquafeeds for Sustainable Aquaculture

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Aquaculture is considered as the key to ensuring enough food protein to feed the growing world population (FAO, 2014). It is expected that the global food demand will increase to 70% in 2050. Aquaculture is touted as the fastest growing food-producing sector in the world. The accelerated growth of the aquaculture sector has resulted in the expansion of aquaculture feed production. However, at present, the aquaculture feed industry is confronted with pressing issues such as the limited availability and escalating cost of dietary fishmeal (FM) and fish oil (FO). FM has traditionally been used in aquaculture feed due to its high protein quality and palatability. However, the success of the aquaculture industry will depend in part on the reduction or replacement of FM use in aquaculture feeds using less expensive alternative protein sources. Several alternative feed ingredients, including plant-derived materials, have been tested in aquaculture feeds for several fish species of economic importance. Meanwhile, other non-conventional protein sources such agricultural wastes and byproducts have been found to hold enormous potentials in future fish feed formulations.

Since 2010, the Japanese Trust Fund (JTF) has been providing research funds to the Aquaculture Department of the Southeast Asian Fisheries Development Center (SEAFDEC/AQD), for the implementation of the regional program "Promotion of Sustainable Aquaculture and Resource Enhancement in Southeast Asia" under the ASEAN-SEAFDEC Fisheries Consultative Group mechanism. Under this program, one of the projects being aggressively carried out by SEAFDEC/AQD focuses on environment-friendly, sustainable utilization and management of fisheries and aquaculture resources, in short sustainable aquaculture. This is aimed at establishing environment-friendly aquaculture technologies that includes assessment of the potentials of locally available plant-derived products and agricultural wastes as feeds in order that food security through sustainable aquaculture could be assured.

Need for alternative protein sources in aquafeeds

Feed is the one of the major contributing factors to the operational cost in fish farming, accounting for 50-70% of production cost. In most ASEAN Member States (AMSs), commercial feeds are too expensive for small-scale fish farmers, limiting their ability to intensify aquaculture production. The increasing cost of commercial feeds has therefore, prompted many fish farmers to search for alternative feeds. Since the aquaculture sector in many AMSs (*e.g.* Philippines) generally depends on the use of imported fishmeal (Sumagaysay-Chavoso, 2007), utilization of locally available ingredients in formulating aquaculture feeds or aquafeeds could reduce production costs.

SEAFDEC/AQD has been conducting studies on the development of cost-effective practical feeds for many tropical species (Millamena, 1996), *i.e.* milkfish, tilapia, catfish, shrimps, grouper, mangrove crab, and pompano (**Fig. 1**), some of the major species cultured in the Philippines. Refinement of formulated diets focuses on the use of inexpensive and indigenous materials in diet development. Previously, a study was embarked by SEAFDEC/AQD with JTF funding, to determine the feasibility of using locally available feed ingredients such as cowpea (*Vigna unguiculata*) meal as an alternative protein source in diets (**Fig. 2**) for the giant freshwater prawn (*Macrobrachium rosenbergii*).

Results of the study showed that cowpea meal can replace fishmeal protein at 30-45% inclusion level with no adverse effects on growth and production of this species when reared under laboratory and lake-based conditions (Aya *et al.*, 2015). Recently, the utilization of fish processing wastes processed as hydrolysates, as fish-feed ingredients has also been tested in diets for grouper (Mamauag and Ragaza, 2016).

Fig. 1. Feeding of formulated feeds to pompano in net cages at AQD's Igang Marine Station in Igang, Guimaras

Fig. 2. Cowpea (*Vigna unguiculata*) meal as an alternative protein source in giant freshwater prawn *Macrobrachium rosenbergii* diets

The increasing world prices of dietary FM and FO has resulted in the search for alternative protein sources. This has been highlighted during the 2001 ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security in the New Millennium: "Fish for the People" and reinforced 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. The latter conference has crafted the Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region towards 2020, which enjoins the SEAFDEC Member Countries to improve the efficient use of aquatic feeds by strictly regulating the quality of manufactured feed and feed ingredients and to support continued research for developing suitable alternative protein sources that will reduce the dependence on fishmeal and other fish-based products. SEAFDEC/AQD has complemented this regional initiative through its program on Healthy and Wholesome Aquaculture, which aims to promote a holistic approach of improving aquaculture production through innovations in nutrition, feed development and fish health management.

In addition to contributing to the attainment of ASEAN's long-term goal of achieving food security and maintaining a healthy environment through sustainable aquaculture practices in the region, the Government of Japan through the ASEAN Foundation (Japan-ASEAN Solidarity Fund), SEAFDEC and the Government of Myanmar spearheaded the conduct of the Regional Technical Consultation (RTC) on the Development and Use of Dietary Ingredients or Fishmeal Substitutes in Aquaculture Feed Formulations in December 2014 in Nay Pyi Taw, Myanmar. The RTC reviewed the status, challenges, and opportunities associated with developing alternative dietary ingredients for aquaculture feed in the ASEAN-SEAFDEC Member Countries; identified the specific advantages being made in the region with respect to the development of alternative aquaculture feed ingredients; and developed policy recommendations (regional and country-specific) relevant to feed formulations and development (Catacutan *et al*., 2015).

The outputs of the RTC include a report on the status on the use of alternative feed ingredients in each AMS (**Table 1**). In such report for instance, Cruz *et al*. (2015) explained the status of development of aquaculture feeds in the Philippines using alternative dietary ingredients that include: a) legumes; b) ipil-ipil (*Leucaena leucocephala*) leaf meal; c) miscellaneous fodder plants, such as the leaves and other aerial parts of papaya, water hyacinth, Ipomea or sweet potato; d) roots and tubers like arrow root (*Maranta arundinacea*), sweet potato (*Ipomea batatas* L.), cassava (*Manihot escolenta* Crantz), taro (*Colocasia esculenta* L.), and elephant yam (*Amorphophallus campanulatus*); e) cereals and cereal byproducts like rice bran and maize; and f) oil cakes and oil meals. Similarly, animal protein sources such as the African snail meal, giant toad meal, fish silage, feather meal, maggot meal, green mussel meal, and superworm (*Zophobas morio*) have also been utilized

Fig. 3. Copra *(above-left)*, soybean *(above-right)*, and rice bran *(left)* are few alternative ingredients for aquafeeds used in the Southeast Asian region

(Cruz *et al*., 2015).

In addition, the working group discussions at the abovementioned RTC identified the issues and strategies on the development of alternative aquaculture feed ingredients for selected commodities in the Southeast Asian region (**Table 2**), where it was also established that in the Southeast Asian region, copra meal, soy bean and rice bran have been commonly used as ingredients in the formulations of aquafeeds (**Fig. 3**). Moreover, the list of regional policy recommendations for the development and use of alternative dietary ingredients in aquaculture feed development in the Southeast Asian region that emanated from the RTC is summarized in **Box 1**.

Agricultural wastes as feed ingredients in aquafeeds

As an agricultural country, the Philippines for instance, has vast land areas that are devoted to farming of agricultural crops. The country's major crop plantations (*i.e*. mango, banana, pineapple, citrus, and other crops) produce large amounts of wastes and byproducts after processing, which if not disposed properly lead to environmental hazard. Therefore, ways to reutilize these wastes and byproducts in aquafeeds merit serious attention. Other agricultural byproducts such as sugarcane bagasse and soybean curd residues are untapped sources of energy and protein for aquaculture feeds, although some of these wastes and byproducts have been used for fertilization and livestock feeds, as well as in the production of functional ingredients or products.

In 2015, with another funding support from JTF, SEAFDEC/AQD implemented a study to explore the suitability of agricultural wastes and byproducts in aquaculture feeds for tilapia (**Fig. 4**). However, the presence of anti-nutritional factors (ANFs) in agricultural wastes and byproducts limits their use as fish feed ingredients. Processing of these agricultural wastes and byproducts using biological treatments (*i.e.* fungi solid state fermentation, inoculation with specific

Table 1. Status of development of alternative dietary ingredients for aquaculture feeds in the AMSs

Country	Status and Issues	Recommendations
Cambodia	• Farmers perceived that low value fishes are available and feeding them would result in better taste and faster growth • The concept on the use of plant protein sources in aquafeed is new and it needs to be proven to farmers that plant protein can replace some fishmeal in feed formulation • Processing technology on the use of fish oil and plant oils is not available and also biotechnology R&D for alternatives for fishmeal and fish oil	• Ensure sufficient amount of ice on boats and landing sites, and during transport to maintain the freshness of fish so that fish by-catch could be used in aquafeed production • Promote the use of fishmeal, plant protein sources and fish oil in commercial aquafeeds for grow-out and prove that aquafeeds for grow-out is profitable and provide better water quality for culture • Intensify information dissemination on best feeding practices and feed formulations to local hatcheries, networks, and grow-out farmers • Train farmers in using fishmeal and plant protein, fish oil, and plant oils in fish feed formulations • SEAFDEC and other agencies to provide technical and financial support to the Department of Aquaculture Development and Aquaculture Research Institute Centers that conduct trials with some volunteer farmers interested in producing homemade aquafeeds • Fisheries Administration of the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Cambodia to provide strong support to commercial feed companies who are keen to set up and operate aquafeed mills in Cambodia • Demonstrate and implement the 90% satiation feeding techniques developed by the United States Soybean Export Council (USSEC) to reduce feed wastes and financial expenditures
Indonesia	• The quality of feed produced by the farmers is not stable because of inconsistent quality of ingredients • Most of the ingredients are seasonally available (*e.g.* local fishmeal, rice bran, etc.) and farmers are not able to purchase them during off-season fish harvest • Presence of anti-nutritional compounds in plant ingredients	• Intensify in-depth research efforts on bioprocessing techniques to reduce anti-nutritional compounds in plant ingredients, as the application of microorganisms through bioprocessing such as fermentation could minimize the cost of improving the quality of alternative ingredients in particular byproducts and wastes from agriculture before being used in diet formulations • Develop the techniques for mass production of high quality alternative ingredients for aquafeed, which could be done through the provision of equipment such as hammer mill and bio-reactor to produce fermented feedstuffs • Institute government programs to centralize the supply of feed ingredients in each province in farming areas through the establishment of a central warehouse in several farming areas across the country to sustain the availability of the local ingredients • Continue providing technical support to improve farmers' knowledge on feed and feeding management, hygiene, and sanitation with the involvement of fisheries extension and fisheries department officials in the development of on-farm feed production
Lao PDR	• Lack of appropriate mass media for each particular area on aquaculture feed; extension officers need special training on feed and feeding • Farmers have very limited opportunities for training • Most training courses are, in general, aquaculture and do not emphasize feed and feeding • Most training courses are not held at the farm sites, so farmers cannot attend	• Establish cooperation on feed and feeding technologies through research and experimentation at the provincial, national, and inter-regional levels • Sustain capacity building of fisheries staff in aquaculture technology and management, with more focus on feeds and feeding technology • Enhance extension network and research collaboration between institutions dealing with inland aquaculture development and education, including feed and feeding technology • Determine the market demand for domestic consumption and processed fish for export • Promote sustainable aquaculture development to encourage aquaculture-industry investments
Malaysia	• Use of blacklisted antibiotics in aquafeed as prophylactic treatment • Most of freshwater aquaculturists feed unprocessed chicken intestine directly to freshwater catfish which brings the issue of hygiene • Concerns on the Halal status of fish diets containing raw materials such as products or byproducts from swine industry • Use of byproducts from farmed fish as feed ingredients for the diets of the same species (also called intra species recycling)	• Promote farming of omnivorous fish species such as tilapia and catfish • Promote consumption freshwater fish • Promote Good Aquaculture Practices (GAPs) to produce quality products certified by DOF Malaysia to increase consumer preferences • Enhance awareness programs for farmers and government officials to implement relevant rules and laws • Intensify R&D on fishmeal and fish oil substitution in aquafeeds with locally available ingredients • Establish networking of suppliers of local ingredients • Put up more aquafeed mills in the country to supply 600,000 MT aquafeed by 2020

Table 1. Status of development of alternative dietary ingredients for aquaculture feeds in the AMSs (Cont'd)

Country	Status and Issues	Recommendations
Myanmar	• Presence of anti-nutrient factors in plant-based ingredients	• Use feed additives, attractants, and synthetic amino acid supplement • Improve processing methods for locally available agriculture byproducts • Review existing policies/regulations on the use of fish bycatch • Use of adulterants and preservatives such as anti-oxidant and mould inhibitor to prevent mycotoxins • Enhance postharvest technology for good quality raw material and improve feed milling technology such as trypsin (moist heat) inhibitor , dehulling, extruding, and pelletizing
Philippines	• Fishmeal are continued to be used as the major source of dietary protein in aquafeed • Invasive species (*e.g.* knife fish and blacklip tilapia) are used as trash fish for the production of mudcrab and shrimps	• Reduce the dependence on the use of fishmeal for aquafeed by active promotion and development of more competitive protein and energy sources from locally available products including cassava, rice, oil palm, and copra • Develop quality aquafeed out of invasive fish species such as knife fish and blacklip tilapia (*Sarotherodon melanotheron*) • Continue the Bureau of Fisheries and Aquatic Resources-initiated Philippine National Aquasilviculture Program that allows the use of the spaces in mangrove areas for aquaculture where stocks are usually mud crab and marine finfishes as well as use available natural food in the environment for their growth • Give special attention to small-scale farmers using farm-made aquafeeds as well as promote organically-formulated diets • Government to give utmost attention to organic agriculture where plant protein sources and byproducts are utilized as source of organic feeds for organic aquaculture • Disseminate technology that uses Green Water Technology in freshwater and inland fisheries, which is recommended not only to reduce cost on feeds but also to avoid possible disease outbreaks caused by viruses and bacteria • Promote tax liberation on imported plant-based protein sources by the government as incentives to feed millers • Continue R&D activities for the production of aquafeeds for species that have low fishmeal requirements
Singapore	• Types of feed used for aqua-farming are natural (trash fish), dry formulated (commercial diet), farm-made (formulated), processed (confectionary), and byproducts (plant waste, fish trimmings, poultry byproducts) • Increasing cost of commercial fish feeds	• Reduce the cost of production from purchasing to converting of feed materials/ingredients into digestible form that involve specialized equipment to extract the desired components • Produce feeds ethically and should undergo stringent testing for any potential toxins that might be created in the process of feed development as this will not only affect the survival and growth of the cultured stocks but also the end users or consumers • Ensure that newly developed feed generate nutrients that will promote good growth and survival of the cultured stocks, and result in good quality fish (*i.e.* rich in omega 3 fatty acid that is beneficial to consumers) • Sustain the availability of materials used as feed ingredients to ensure continued production of fish feeds
Thailand	• Fishmeal can be replaced to a large extent but at higher cost (*e.g.* enzyme and amino acid supplementation) • Supply of fishmeal from local production not is enough, while production faced challenges from illegal, unreported and unregulated (IUU) fishing • Problems on the use of genetically modified (GM) plants • Fish oil considered as serious limiting factor	• Enhance the utilization of fish-by-catch or FBC (*e.g.* fish processing trimmings) as fishmeal, fish silage, and fish hydrolysates in aquafeed production • Give focus on the production of commodities for export or high value domestic aquatic animals to make the utilization of imported ingredients (*e.g.* fishmeal, soybean meal, fish oil) more feasible • Government sector to give attention to IUU fishing, environmental regulations, national aquafeed legislation, researches, and extension of information/knowledge to farmers and feed mills • Feed millers/manufacturers to improve feed quality, reduce leaching of nutrients, and improve digestibility of feeds to reflect the real feed cost • Farmers to understand feeding regimes, culture systems, and marketing (domestic or export)

Table 1. Status of development of alternative dietary ingredients for aquaculture feeds in the AMSs (Cont'd)

Country	Status and Issues	Recommendations
Viet Nam	• Little information on fish bycatch and the recent number of fishmeal plants • Certification of local fishmeal quality should meet international standards • Animal feed mills and aquafeed mills do not use local fishmeal of good quality; imported fishmeal is used while the local fishmeal is exported • Soybean production is small and utilized mostly for human consumption • Soybean for aquafeed use is imported • Few studies on fishmeal and fish oil replacement • Plant oil not used widely in aquafeed because plant oil contains less omega 3	• Government of Viet Nam to have a long-term policy to grow plant protein sources, particularly soybean • Government to issue regulation for harvestable size of any marine species for sustainable importation • Local fishmeal plants o show transparency of information regarding volume and quality of local fishmeal that can be accessed through website • Local fishmeal plant operators to work together to control the quality of trash fish from capture fishery • Private companies and government to develop a long-term program for replacement of marine animal ingredients with alternative sources, using bioactive products such as NOVAQ (aquaculture feed developed in Australia) or "like NOVAQ" or bioflocs system • Donors to support efforts to overcome the effects of climate change and value chain programs for fish by-catch and aquaculture products

Source: Catacutan et al. (2015)

Fig. 4. Agricultural wastes and byproducts currently being converted into valuable protein sources in tilapia diets: (**A-B**) pineapple peels; (**C**) sugarcane baggase; (**D**) okara meal or soybean curd residues; (**E-F**) citrus pulp and peels

Table 2. Issues and strategies on the development of alternative aquaculture feed ingredients for selected commodities in the Southeast Asian region

Issues/Gaps	Strategy/Recommendation
Herbivores (*e.g.* milkfish, carps, barbs)	
• Inadequate information on alternative feed ingredients from plant-based sources • Some alternative ingredients are not available locally in many countries in the Southeast Asian region • Presence of anti-nutritional factors affect the nutritional value of many alternative feed ingredients from plant sources • Incomplete information on proximate composition of many alternative ingredients from plant sources • Limited study on the feeds and feeding of herbivorous species • Poor digestibility of many plant protein ingredients • Low efficiency of feeds (*i.e.* high feed conversion ratio)	• Compile and disseminate information on alternative plant products and facilitate exchange of information both within and outside the region • Define and apply strategies that will encourage production of locally available alternative ingredients • Create and implement policies that will facilitate the outsourcing of other alternative ingredients • Enhance R&D efforts in processing to improve the nutritional value of the alternative ingredients • Conduct profiling or characterization of the alternative ingredients • Continue R&D to improve the efficiency of feeds, particularly on the food conversion ratio or FCR • Strengthen collaboration among the government sector (particularly the policy makers), R&D institutions, and the private sector

Table 2. Issues and strategies on the development of alternative aquaculture feed ingredients for selected commodities in the Southeast Asian region (Cont'd)

Issues/Gaps	Strategy/Recommendation
Omnivores (*e.g.* pangasius, tilapia)	
• Need of additional potential alternative protein sources • Limited information on quality of alternative ingredients • Lack of information on economic feasibility of using alternative ingredients that can replace fishmeal • Inclusion levels of peanut meal in feeds for tilapia are not known • Different strains of genetically improved tilapia have varying responses to alternative protein sources • Insufficient information/knowledge of small-scale farmers on proper utilization of feeds	• Improve post-harvest and/or processing technologies to enhance the quality and nutritional value of alternative feed ingredients (*e.g.* peanut meal), and strengthen research collaboration to address the issue on determining the nutritional value of the new or improved ingredients (*e.g.* amino acid analysis) • Conduct national assessment of ingredients in each country in terms of availability, sourcing, sustainability and cost effectiveness which will lead to selection of specific ingredients in the country • Promote mass production of protein sources/ingredients that are found appropriate after each assessment by country • Establish/enhance collaboration with the agriculture sector for the mass production of alternative protein source ingredients • Determine optimum inclusion levels (for peanut meal and also for soybean meal) and response of the species in terms of growth and meat quality • Generate information on nutrient digestibility of genetically improved strains of tilapia through joint efforts among institutions with appropriate facilities and expertise • Disseminate information to farmers through training programs for extension officers, distribution of information materials • Conduct demonstration of field trials on the use of traditional feeds, especially those with new alternative feed ingredients, involving the cooperation of farmers, extension workers and feed millers
Carnivore (*e.g.* catfish, snakehead, seabass, grouper, black tiger shrimp)	
Freshwater fishes: *Catfish*	
• Small-scale farmers are still dependent on on-farm feeds • Non-availability of data on actual utilization of imported and local fishmeal in feed formulations as feed companies usually do not release the detailed contents of fishmeal in commercial formulated diets	• Conduct research on feed development for catfish, particularly on nutrient requirements and protein source substitution (with emphasis on the use of alternatives to fishmeal) • Refine existing technology on formulation of catfish feeds • Facilitate sharing of information for further development of feeds
Freshwater fishes: *Snakehead*	
• Heavy reliance on trash fish as feed source (about 15% of fishmeal are included in aquafeeds) • Most feed ingredients are imported and some governments regulate the growing of plant-based protein sources such as soybean	• Promote the use of pellet feed instead of trash fish • Conduct further studies to clarify the requirements of fishmeal in snakehead diets • Encourage farmers to grow plants which have the potentials as feed ingredients
Marine fishes: *Sea bass*	
• Sea bass cultured in freshwater and seawater have varying nutrient requirements • Commercial feed (>43% CP) for this species is readily available in some countries such as Thailand and Viet Nam but data on actual utilization of fishmeal are not available • Lack of diets for broodstock • Most feed ingredients used in feed formulations are imported	
Marine fishes: Grouper	
• Lack of research on suitable larval feeds • Commercial feed formulations use at least 30% imported fishmeal • Heavy reliance on trash fish in feeding grouper • Commercial feeds (46-50% CP) for grouper are readily available in Indonesia but data on actual utilization of fishmeal are not available	• Carry out research to determine suitable larval feed for grouper and suitable broodstock diets for sea bass cultured in freshwater and seawater • Conduct R&D on fishmeal substitution for sea bass and grouper diets • Enhance collaboration among government, R&D institutions, feed industry and farmers on initiatives related to development of good quality feed and protein source substitution
Crustaceans (*e.g.* black tiger shrimp)	
• Reliance on both local and imported feeds but dependence on imported fishmeal in shrimp feed production is increasing • Lack of diets specific for broodstocks • Lack of high quality alternative protein sources for use in aquafeed formulations	• Conduct R&D on fishmeal substitution for shrimp diets • Carry out research to determine suitable diets specific to shrimp broodstock

Source: Catacutan et al. *(2015)*

Box 1. Summary of relevant policy recommendations on feed formulations/development	
Key Problems	**Policy Recommendations**
Inadequate knowledge and technology	• Continue research and development activities for the production of aquafeeds with low or minimal fishmeal content • Provide focus on research and development on aquafeeds quality, improved formulation, and use of alternative dietary ingredients • Develop techniques for mass production of high quality ingredients to replace fishmeal and fish oil in aquaculture feeds • Create a network or a regional forum for exchanging and sharing of R&D on feed formulation and efficiency, and feeding management practices • Provide technical support to improve farmer's knowledge on feeds and feeding management, hygiene, and sanitation • Facilitate exchange of information and cooperation with other regions
Supply of fishmeal and feed ingredients from IUU fishing and genetically modified organism(GMO)	• Assess the production capacity of feed milling plants, including the import- export volume of (the raw materials for feed ingredients • Establish and apply the traceability system of all raw materials used as feed ingredients through the application of the Catch Documentation System (CDS) • Create a government program in AMS to encourage the mass production of local feed ingredients and establish a centralized supply of feed ingredients in each local government • Establish the supplier networks of local ingredients
Lack of regulations and/or fishery acts and cooperation to manage development of aquafeeds	• Establish a national aquafeed quality control to ensure high compliance of feed milling companies to fisheries regulations • Establish SEAFDEC Aquaculture Department (AQD) as a focal agency of ASEAN programs on development and use of alternative dietary ingredients in aquaculture feed development. As the focal agency, AQD will work closely with AMSs, research institutions, academe, industry, and inter-regional organizations • Create an ASEAN forum or network that includes all stakeholders on development and use of alternative dietary ingredients in aquaculture feed development • Formulate the National Action Plan on development and use of alternative dietary ingredients in aquaculture feed development • Enhance awareness on the importance of reducing dependence of aquaculture on feed and ingredients of marine animal origin

Source: Catacutan et al. *(2015)*

microorganisms, among others) to reduce their ANFs (*e.g.* tannin, phenol, saponin, lignin and alkaloid) would enable higher inclusion level in fish feeds. When developing feedstock from agricultural wastes, potential safety issues regarding pesticide residues (*e.g.* organochlorines, pyrethroids, and organophosphates) should also be identified. The nutritional quality, digestibility, and suitability as feeds, economic analysis should also be determined to assess the viability and profitability of using these agricultural wastes and byproducts in aquaculture feeds.

Way Forward

Continuous research on alternative protein sources such as plant-derived feed ingredients, fish processing wastes, underutilized crops, and insect-based meal needs to be done. Development of cost-effective processing techniques to convert these alternative feed ingredients should also be addressed to make the aquaculture feed production in the Southeast Asian region sustainable. The Philippines is a major tuna producer in the Western and Central Pacific Ocean (Barut and Garvilles, 2015), and where tuna processing is also a major industry with landing areas located in the cities of General Santos and Zamboanga, in Mindanao.

Byproducts from canned tuna processing are utilized in fishmeal production (Sentina, 2013). Nevertheless, the beneficial use of tuna byproducts as fishmeal replacement in aquaculture feeds in the Philippines is an interesting area which remains to be studied to maximize its potential. Tuna byproducts appear to be a good protein substitute for fishmeal in aquaculture feeds because of its high nutritional quality, which could even be further improved by combining these with agricultural feed sources during the fermentation process.

Studies on the use of fisheries processing wastes blended with agricultural byproducts as complementary ingredients in diets for cultured fish species in Southeast Asia should therefore be conducted. Agricultural and fish processing wastes and byproducts have very low or no commercial value, and are readily available in large quantities, making them excellent alternative ingredients to aquaculture feeds. Appropriate and low-cost treatments to increase their nutritional value are likewise needed and their suitability should be tested in diets for farmed fish species (Mamauag, 2016).

Utilization of these agricultural and fish processing wastes and byproducts will provide cost-effective and more sustainable feed alternatives to increase farm productivity, and more importantly, reduce the negative impacts to the environment.

SEAFDEC/AQD will continue to conduct a wide array of research to improve the performance of aquaculture feeds, as well as explore the development of low fishmeal and/or plant-based aquaculture feeds derived from locally available ingredients to replace ingredients obtained from imported crops and fishmeal. In addition, SEAFDEC/AQD will spearhead the development of database of alternative feed ingredients for use in aquaculture feeds, and exchange of information among the AMSs on alternative feed ingredients would also be actively pursued.

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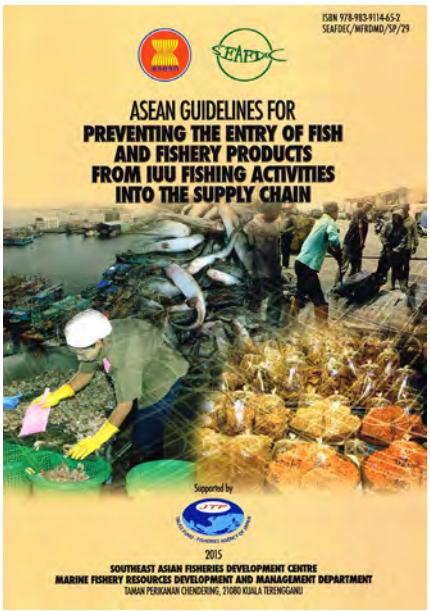
Preventing the Entry of IUU Fish and Fishery Products into the Supply Chain: the Regional Guidelines

Abdul Razak Latun, Mazalina Ali, Raja Bidin Raja Hassan, and *Virgilia T. Sulit*

The increasing demand for fish has driven fishers to catch more fish, to the extent of practicing illegal, unreported and unregulated (IUU) fishing. IUU fishing not only contributes to overexploitation of the stocks but also hindering the recovery of fish populations and the ecosystems; and damaging the marine habitats and putting those fishers who operate legally at a disadvantage, adversely affecting the economic and social well-being of fishing communities. A serious global concern, IUU fishing is difficult to quantify as it can occur in virtually any fisheries from inland waters, shallow coastal or even in offshore areas. It is a particular issue in developing countries, especially in Southeast Asia where fisheries management strategies need to be strengthened, resources for landing controls and vessel inspections are inadequate, and the number of patrol vessels is limited to enforce the necessary regulations. Nevertheless, most countries in the Southeast Asian region have developed and/or enhanced their respective regulations in fisheries management in accordance with the Regional Guidelines for Responsible Fisheries in Southeast Asia and taking into consideration the EC Regulation 1005/2008 to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing. Therefore, the Southeast Asian countries are able to support any efforts that make use of trade measures to combat IUU fishing in the region. However, the countries should be willing to take on the primary responsibility of adopting the countermeasures to combat IUU fishing in the region.

The SEAFDEC Marine Fishery Resources Development and Management Department (MFRDMD) collaborated with the ASEAN Member States (AMSs) for the implementation of the JTF-funded project "Combating IUU Fishing in the Southeast Asian Region through Application of Catch Certification for International Trade in Fish and Fishery Products" which was launched in 2013. Implemented through core experts meetings and regional technical consultations, the project involves identification of existing trade practices and mechanisms in small-scale fisheries, and the associated problems encountered by the AMSs in complying with the EC Regulation No.1005/2008 for large-scale capture fisheries in the regions, anchoring on the provisions indicated in Resolution No. 8 and Plan of Action No. 67 of the ASEAN-SEAFDEC Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2020 that were adopted in 2011 (SEAFDEC, 2011). The information gathered from the AMSs were analyzed to provide a basis for the development of a catch documentation system for combating IUU fishing in the Southeast Asian region with possible expansion and/or modification of the relevant regulations on international trade in fish and fishery products within the region.

Through the series of meetings and consultations in from 2013 to 2015, MFRDMD was able to analyze the information compiled from the AMSs on the issues, processes and procedures in exporting fish and fishery products from the Southeast Asian region, and harmonized such information for the development of the necessary regional guidelines that aim to prevent the export of IUU fish and fishery products (Latun *et al*., 2013), which is now known as the "ASEAN Guidelines for Preventing the Entry of Fish and Fishery Products from IUU Fishing Activities into the Supply Chain." While providing full support to the development of such Guidelines that was spearheaded by MFRDMD and promoting the implementation of the Guidelines in the region, the AMSs also recognized that regional cooperation should be strengthened to address the various issues, concerns, and anticipated difficulties that the countries encounter in the implementation of the Guidelines.



Through the series of consultations, MFRDMD established that such constraints could include: inadequate legal frameworks for implementing some parts of the Guidelines, *e.g.* installation of vessel monitoring systems in large-scale fishing vessels; inadequate resources, both human and financial; and insufficient knowledge and awareness on the benefits and advantages of adopting a traceability system in fisheries operations (Latun *et al*., 2016). The intention the

Box 1. Recommended Actions to implement the "ASEAN Guidelines for Preventing the Entry of Fish and Fishery Products from IUU Fishing Activities into the Supply Chain"

Action 1: Managing fishing activities within an ASEAN Member State (AMS)

1.1 Control of fishing access

- Evaluate existing systems that control fishing access
- Conduct capacity building to share/exchange experiences among the AMSs in controlling fishing access
- Revise policy, fisheries regulation, legal framework and procedures when and where appropriate
- Request SEAFDEC for capacity building on electronic database system
- Encourage AMS to share their experiences to help other member states in developing their national electronic database system including that of fishing license

1.2 Promotion of responsible fishing practices/methods

- Promote responsible fishing practices/methods in the region in accordance with the CCRF
- Consider developing and implementing NPOA-IUU and NPOA-Capacity
- Review and strengthen capacity building on MCS
- Promote awareness program on responsible fishing practices and methods

1.3 Strengthening efforts to attain sustainable fisheries

- Update related laws and regulations as well as systems of reporting catch and compiling appropriate logbook information by evaluating and strengthening regulations on catch declaration, and developing, implementing, and improving a systematic catch declaration through logbook/e-logbook
- Monitor all fishing vessels by maintaining records and their performance with respect to compliance to national laws and regulations, and strengthening fishing vessels inspection and enforcement program
- Promote MCS through the implementation of VMS, and by considering the development of national strategic plans for monitoring movement and activities of fishing vessels; equipping appropriate fishing vessels with suitable fishing vessels monitoring system; and seeking the advice of SEAFDEC on the principles of fishing vessel monitoring systems
- Intensify efforts to address IUU fishing including destructive fishing by promoting co-management approach for fisheries management, and strengthening the capability of fisheries enforcement staff and agency to combat IUU fishing

1.4 Intensifying surveillance during fishing operations and port state control at designated landing ports

- Enhance capacity building on MCS, and consider intensifying surveillance during fishing operations by increasing the frequency of inspection at sea
- Consider the implementation of relevant port state measures

Action 2: Regulating transshipment and landing of fish/catch across borders

2.1 Establishing formal arrangements with respect to landings between bordering countries

- Strengthen cooperation and collaboration between bordering countries with respect to landing
- Request assistance from SEAFDEC to facilitate formal arrangement with respect to landing between bordering countries

2.2 Conduct of regular bilateral/multi-lateral meetings to agree on licensing system/data recording and to share relevant information and fishing vessel registration database

- Consider active participation in bilateral/multi-lateral meetings with bordering countries in licensing system/data recording and sharing of relevant information
- Consider sharing relevant information among AMSs especially with the RFVR Database, including vessels less than 24 meters in length

2.3 Ensure that port States should strengthen measures to regulate fishing vessels accessing their ports for trans-shipping and/or landing catch and collect and exchange relevant information including origin of catch, among neighbouring countries

- Consider developing and implementing an appropriate regional catch documentation scheme (ACDS) including an electronic system
- Conduct capacity building on port state measures and catch documentation scheme
- Consider formulating SOPs/manuals for better understanding and implementation of FSM, PSM and CSM
- Consider strengthening effective monitoring at landing sites including preventing entry of fish and fishery product from IUU fishing

Action 3: Preventing poaching in the EEZs of ASEAN Member States

3.1 Enforce actions against fishing vessels operating illegally beyond their designated areas, for example by using some system of vessel monitoring system (VMS), implementation and strengthening of flag States measures, port State measures and coastal State measures

- Encourage cooperation with other AMSs on VMS data sharing upon request
- Strengthen inspection and surveillance against fishing vessels operating illegally beyond their designated areas
- Enhance cooperation among national management and enforcement agencies

3.2 Compile record of blacklisted illegal vessels operating beyond their respective EEZs and share record among the AMSs

- Share information among AMSs on the blacklisted vessels engaged in IUU fishing

3.3 Ensure regular updating of information for the regional fishing vessels record (RFVR)

- Share and update regularly the information on fishing vessels 24 meters in length and over, with the RFVR Database
- Request SEAFDEC to consider developing the RFVR Database System for fishing vessels less than 24 meters in length

3.4 Establish bilateral/multilateral agreements for permission to fish in each other's fishing areas

- Consider establishing bilateral/multilateral agreements for permission to fish in AMSs waters

Action 4: Controlling illegal fishing and trading practices of live reef food fish (LRFF), reef-based ornamentals and endangered aquatic species

4.1 Conduct regular inter- and intra-meetings among relevant authorities (including Customs Departments) and exporting companies for establishing agreements on harvesting practices and data reporting of LRFF, reef-based ornamentals, and endangered aquatic species

- Strengthen collaboration among relevant agencies and stakeholders including exporting companies to establish agreements on harvesting practices and data reporting of LRFF, reef-based ornamentals, and endangered aquatic species

Box 1. Recommended Actions to implement the "ASEAN Guidelines for Preventing the Entry of Fish and Fishery Products from IUU Fishing Activities into the Supply Chain" (Cont'd)	
4.2	**Develop appropriate mechanisms for the monitoring and data collection of LRFF and reef-based ornamentals trades** • Apply co-management mechanisms for collecting information on LRFF and reef-based ornamentals trades • Strengthen data collection and analysis of trading of LRFF, and reef-based ornamentals
4.3	**Ensure that export of endangered aquatic species is avoided, except for research and experimental purposes for which such export should be accompanied by appropriate documents** • Strengthen regular monitoring and surveillance on the export of endangered aquatic species • Encourage AMSs to review respective existing regulations to comply with CITES and strengthen awareness building program for stakeholders • Enhance collaboration among relevant agencies monitoring and surveillance on the export of endangered aquatic species
4.4	**Enhancing the participation of small-scale/artisanal fishers who account for majority of LRFF production, in co-management and enhancing their awareness of the impacts of IUU fishing and trading of such aquatic species** • Encourage development of co-management program for participation of small-scale or artisanal fishers in LRFF production • Create, promote and implement the awareness program on the impact of IUU fishing and trading of such aquatic species
4.5	**Establishing a network between LRFF importing and exporting countries, and strengthening LRFFT management at the regional level** • Seek the assistance of SEAFDEC in facilitating the establishment of the regional LRFFT network • Encourage AMSs to join and actively participate in the regional LRFFT network once it has been established
Action 5: Strengthening the management of fishing in the high seas and RFMO areas	
5.1	**Strengthening Port State Measures (PSM)** • Promote capacity building for relevant AMS officials to better understand and implement PSM
5.2	**Implement where appropriate, Observer Programs in accordance with relevant national, regional or international regulations with respect to high seas fisheries** • Encourage AMSs to develop and implement Observer Programs in accordance with relevant national, regional or international regulations with respect to high seas fisheries • Enhance capacity building for the implementation of Observer Programs
5.3	**Cooperate with relevant RFMOs in complying with their Catch Documentation Schemes to prevent the landing of fish and fishery products from IUU fishing in RFMO areas** • Encourage AMSs to cooperate with the relevant RFMOs in complying with the RFMOs Catch Documentation Schemes • Explore the possibility of harmonizing the Catch Documentation Schemes

AMSs and SEAFDEC through MFRDMD, is for the ASEAN Guidelines to serve as the foundation in formulating the relevant policies at national level as well as in developing clear direction and understanding of the need to prevent the entry of IUU fish and fishery products into the supply chain (Ali *et al*., 2015). Since its printing in 2015, the ASEAN Guidelines has been promoted by MFRDMD for implementation in the AMSs, and the extent of such implementation was analyzed.

Implementation of the ASEAN Guidelines

At the onset of the promotion of the implementation of the ASEAN Guidelines, MFRDMD consulted with authorities in selected countries of the AMSs. The countries agreed that the AMSs should formulate their respective national action plans for the smooth and total implementation of the Guidelines, taking into consideration the recommended actions to implement the Guidelines, agreed upon during the series of consultations among the AMSs (**Box 1**).

Extent of Implementation of the "ASEAN Guidelines for Preventing the Entry of Fish and Fishery Products from IUU Fishing Activities into the Supply Chain" in the Region

As agreed during the series of consultations to discuss the development of the ASEAN Guidelines, the AMSs agreed that the implementation of the ASEAN Guidelines would imply that the AMSs undertake all the actions necessary for combating IUU fishing through market measures, *e.g.* illegal fish and fishery products from IUU activities should not be allowed to be traded. This is considering that the ASEAN Guidelines is the central measure which covers not only market measures such as documentation of catches but also incorporates the MCS approaches including registration of fishing vessels, licensing of fishing gears used for fishing operation, recording of catch, and designation of landing areas and control of foreign fishing vessels through the implementation of port State measures.

Moreover, MFRDMD was also able to establish that IUU fishing activities in the region had expanded to include illegal trading of IUU fishes. Results of further consultations indicated that this allegedly emanated from the weak enforcement of regulations and frameworks aimed at combating IUU fishing (Kawamura and Siriraksophon, 2014). For such reason, the AMSs agreed to intensify the promotion of the ASEAN Guidelines in the region (Latun *et al*., 2016a).

During the recent Regional Technical Consultation convened in 2017, a self-assessment by the AMSs was conducted on the role that the countries play in promoting the Regional Guidelines. The results showed the status of implementation of the Guidelines in AMSs which varies from 46% to 91%. The variation was due to the existence of legal frameworks

Table 1. Extent of implementation of the Regional Guidelines in the AMSs

Recommended Actions to Implement the ASEAN Guidelines		% Implementation of the Guidelines in AMSs									
		BR	KH	ID	LA	MY	MM	PH	SG	TH	**VN**
Action 1	Managing Fishing Activities within an ASEAN Member State (AMS)	68.14	65.76	87.80	46.44	88.47	84.07	80.68	70.17	90.85	76.61
Action 2	Regulating Transhipment and Landing of Fish/ Catch Across Borders										
Action 3	Preventing Poaching in the EEZs of ASEAN Member States										
Action 4	Controlling Illegal Fishing and Trading Practices of Live Reef Food Fish (LRFF), Reef-based Ornamentals and Endangered Aquatic Species										
Action 5	Strengthening the Management of Fishing in the High Seas and RFMO Areas										

Note: BN: Brunei Darussalam; KH: Cambodia; ID: Indonesia; LA: Lao PDR; MY: Malaysia; MM: Myanmar; PH: Philippines; SG: Singapore; TH: Thailand; VN: Viet Nam

that is already in-place and the management capabilities of the AMSs. Based on the Recommended Actions to implement the "ASEAN Guidelines for Preventing the Entry of Fish and Fishery Products from IUU Fishing Activities into the Supply Chain," the information provided by the AMSs on the extent of implementation of the Guidelines has been compiled as shown in **Table 1**.

Way Forward

Throughout the duration of the project which is until 2019, MFRDMD would continue to promote implementation the Guidelines in the AMSs. Technical assistance through capacity building activities would also be provided to enable the AMSs to adopt the ASEAN Guidelines, since its total implementation would mean significant reduction in the IUU fishing activities in the Southeast Asian region.

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Automating Marine Fisheries Catch Documentation Schemes: the eACDS

Somboon Siriraksophon, Pramuan Rukjai, Prach Konphet, and *Namfon Imsamrarn*

Market-driven measures, enforced to control the trading of fish and fishery products, specifically, the EC Regulation 1005/2008, have impacted not only the countries that send their products to the EU but also some countries that do not directly export their fish to the EU but need catch certifications. For the conservation and management of tunas, the respective member countries of the Regional Fisheries Management Organizations (RFMOs) adopt the Catch Documentation Schemes of the RFMOs. Based on such market-driven measures, relevant ASEAN Member States (AMSs) that trade their fish and fishery products are also bound to implement the measures. The AMSs recognize that measures are necessary to improve the traceability system of capture fisheries and combat IUU fishing in the region. Catch documentation scheme is one of the management tools that could enhance and strengthen the management of the region's fisheries as well as support intra-regional and international trade of fish and fishery products beyond trading either with the EU or under the framework of the RFMO areas. Based on the abovementioned circumstances, issues pertaining to the EC Regulation 1005/2008 and traceability of capture fisheries had been immensely discussed by the AMSs in various fora, where support was expressed on the need to improve and develop the traceability for capture fisheries to ensure the sustainability of fisheries for food security as well as to prevent the entry of IUU fish and fishery products into the supply chain in the Southeast Asian region. Accordingly, the development of a common ASEAN Catch Documentation Scheme that takes into consideration the format, standards and information requirements of the importing countries but simplified to enhance its applicability by the small-scale fisheries in the region, was endorsed.

The Southeast Asian region is a major producer of fish and fishery products, accounting for a quarter of the global fish production. Of the world's top 20 marine capture fisheries producers, six are from the region, namely: Indonesia, Viet Nam, Philippines, Thailand, Malaysia, and Myanmar. Indonesia ranked second of the world's highest marine capture fisheries producers with production of 6.50 million metric tons (MT) in 2015 an increase of about 41% over the last decade. The FAO Fisheries Global Information System (Figis, 2017) showed that the total production of Indonesia from marine capture fisheries in 2015 (including mollusks and crustaceans) reached 6.49 million MT, followed by Viet Nam at 3.48 million MT, Philippines at 2.06 million MT, Thailand at 1.91 million MT, Malaysia at 1.54 million MT, and Myanmar at 1.14 million MT. It is worth noting that production from marine capture fisheries of Viet Nam increased by 54% over the last decade.

The global demand for the region's fish and fishery products is rising, as more countries are dependent on fish supply from the region. Australia sources nearly half of its fish demand from the Southeast Asian region, and studies have shown that Australia's domestic fish requirement would reach 776,000 MT by 2020, of which 610,000 MT would be imported. Japan, which is Southeast Asia's major trading partners has been the leading importer of seafood in the world. In 2011, Japan's seafood import reached 2.69 million MT amounting to 1.45 trillion Yen. Japan imports shrimps primarily from Viet Nam, Indonesia, and Thailand. Indonesia is also one of the country's major sources of tuna, third to Taiwan and Korea. This growth was driven by the increased demand from Europe and the United States. Viet Nam's seafood is also in demand as exports grew from US$ 5.0 billion in 2010 to US$ 6.2 billion in 2012. The United States is fast rising as a major importer of seafood from Viet Nam. It is the primary importer of tuna and the second largest importer of shrimps from Viet Nam. Thailand and Vietnam are two of the world's major exporters of fish and fishery products.

Development of the ASEAN Catch Documentation Scheme

The ASEAN Catch Documentation Scheme (ACDS) concept was developed in close collaboration with the SEAFDEC Technical Departments, experts and fisheries policy makers from the SEAFDEC Member Countries. Expert group meetings and regional technical consultations were convened by SEAFDEC to draft the ACDS (Siriraksophon *et al.*, 2016), which was later discussed at the Stakeholder Consultations in March 2016 where views were compiled for the development of an appropriate system of ACDS, both in electronic format and manual system to address the requirements of the SEAFDEC Member Countries. In addition, SEAFDEC need to be assured that the ACDS would be applicable and beneficial to relevant stakeholders, *e.g.* operators of fishing vessels, suppliers, seafood processors for export, and traders.

The ACDS is meant to: provide a unified framework that will enhance the traceability of fish and fishery products for effective marine fisheries management in the AMSs; enhance the credibility of fish and fishery products for intra-regional and international trade; and prevent entry of fish and fishery products from IUU fishing activities into the supply chain of AMSs. In addition, the ACDS could also enhance the cooperation among the AMSs for the advancement of the ASEAN Economic Community (AEC).

Voluntary for all AMSs, the ACDS applies to trade of marine fish and fishery products, processed or not. In this connection, a catch certificate and details of transshipment shall accompany all catches, either transshipped, landed, exported, imported, or re-exported, under the jurisdiction of the AMSs, and there is no waiver for this requirement. The ACDS would also cover catches from small fishing vessels that contribute to trade among the AMSs, where a simplified catch document would be applied accordingly for such cases.

To support better understanding to SEAFDEC Member Countries on the usage and effectiveness of the ACDS on fisheries management through the enhancing of traceability system for marine capture fisheries, the Infographics of the ACDS Guide was published (SEAFDEC, 2017; SEAFDEC, 2018 (2nd ed.)). The ACDS Guide consists of 5 groups with 17 scenarios of catch and trade flows into and/or among the AMSs, namely: (1) Fish from Flag State Vessel Operating within the EEZ; (2) Fish from Flag State Vessel Operating outside the EEZ and/or Neighboring AMS; (3) Transshipment at Sea within the EEZ; (4) Fish from Flag State Vessel Operating in the High Seas and/or RFMO's Area of Competent; and (5) Imported Fish across the Border by Land Transportation.

Furthermore, at the Forty-ninth Meeting of the SEAFDEC Council in April 2016, it was suggested that an electronic system of the ACDS (eACDS) should also be developed by SEAFDEC not only for the commercial fisheries but also to support the small-scale fishers. The eACDS should also be harmonized with other existing catch documentation schemes to ensure that this would support the requirements of various trade regulations, *e.g.* EC Regulation 1005/2008, US Presidential Task Force including the two new US Seafood Traceability Programs. Thus, trading of fish and fishery products from the Southeast Asia would be enhanced. The SEAFDEC Council also endorsed Brunei Darussalam as a pilot site to test the eACDS.

Electronic System of the ASEAN Catch Documentation Scheme

In the development of the eACDS, SEAFDEC reviewed the existing similar Catch Certification Systems adopted by some AMSs, such as the Ministry of Marine Affairs and Fisheries (MMAF) of Indonesia and Department of Fisheries of Thailand that operate the system to accommodate the requirements by importers from the EU. SEAFDEC also learned the Catch Documentation for toothfish (*Dissostichus* spp.) under the Area of Competent of the Commission on the Conservation of Antarctic Marine Living Resources (CCAMLR), entered into force in 2015. Additionally, the lessons learned from the Swedish Agency for Marine and Water Management (SwAM)

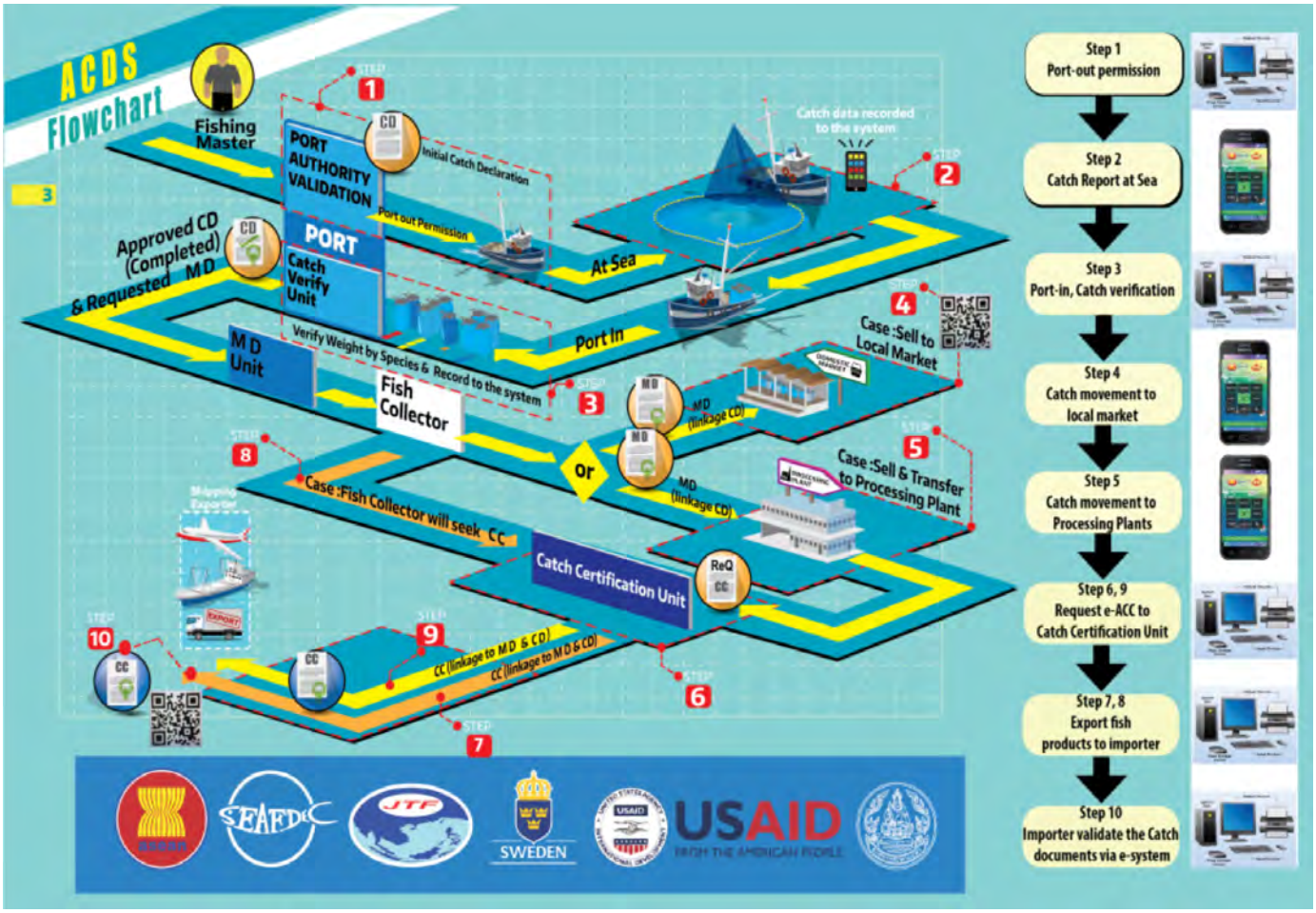

Fig. 1. Flowchart of the implementation of the eACDS at country level

were also referred to particularly on monitoring the fishing vessels activities and catch flow system from sea to landing site, processing producers and/or consumer market. Lastly, SEAFDEC observed the electronic system of the Movement Catch Purchasing Documents (MCPD) developed by the Fish Marketing Organization (FMO) of Thailand, after which SEAFDEC signed an MOU with FMO in November 2016 for the development of the eACDS for the AMSs.

With reference to the definition of Catch Documentation Scheme or CDS which is a "tracking system that monitors the fish from point of catch through to its final destination preventing the entry of IUU fish products into the market," and based on the above lessons learned, the architectural design of the eACDS was therefore finalized as shown in **Fig. 1**. The eACDS consists of three main processes (**Box 1**), namely: (1) Issuance of Catch Declaration (CD); (2) Issuance of Movement Document (MD); and (3) Issuance of Catch Certification (CC). Based on these processes, the importer would be able to make clearance on the CC and trace the origin of fish and fish products along the supply chain. Implementation of the eACDS for domestic fisheries involves 10 steps (**Box 2**) as also shown in **Fig.1**.

Box 1. The processes involved in the eACDS

Issuance of Catch Declaration (CD): This process includes many activities at home port and at seas, such as the port-out control, issuing the initial CD to fishing master, reporting of the estimated catch at point of catch via mobile application, port-in control, verifying the catch weight, and issuing the approved CD to fishing master.
Issuance of Movement Document (MD): This process includes the purchasing activities by key actors such as fish buyers, fish agents, fish processors and all stakeholders concerned in the process. The eACDS system requires that all catch are recorded either at the final local market or at the processing plants while the MD will be generated and verified by the authorized fishery officer at fishing ports and provided to the end process.
Issuance of Catch Certification (CC): This process includes the request for CC from the processors via online application, validation of the traceability of origin of fish in the process from catch to fishery products, issuing of the CC by the Competent Authority (CA) established by the responsible authority on fisheries.

For marine capture fisheries, the eACDS requires many basic data and information known as "Key Data Elements" (KDEs) to ensure and enhance the efficiency of the system and support more effective fisheries management and good governance. The KDEs (**Box 3**) can be grouped into six (6) categories, namely: 1) Point of Catch; 2) Buyers/Receivers and Sellers (Broker/Wholesale); 3) Processors; 4) Exporters and International Shipping; 5) Importers; and 6) End Consumers.

Web-based Application of the eACDS

With the collaboration of the FMO of Thailand, SEAFDEC developed the eACDS with Web-based and mobile applications to support the users from different sectors throughout the supply chain of fish and fishery products. The

Box 2. Steps in the implementation of the eACDS

Step 1 - Port-out control: Fishing Master should inform the Fishing Port Authority before going out for fishing operation, while the validation of fishing license is one of the key parameters for permitting the fishing master to go to sea. In this process, the Fishing Port Authority will issue the initial CD with password for accessing the mobile application for catch reporting at sea.
Step 2 - Catch reporting at sea: after each fishing operation at sea, fishing master should report their estimated catch via mobile eACDS application using the access accounts and password that appear on the initial CD form.
Step 3 - Port-in control and catch-weight verification: After operation at sea, the vessel moves back to fishing port for Port-in control. In this regard, Fishing Master should report to the Port-in control. The weight of catch on fishing vessels should be verified again by the Fishing Master at port, and the verified catch are recorded on the system. Throughout this process, the Fishing Master will receive the Catch Declaration from the Fishing Port Authority
Step 4 - Catch movement to local market: In case the catches go directly to local market after the purchasing process at landing site, the Movement Document (MD) will be issued by Fishing Port Authority and given to the buyer. At local market, the consumers can trace the origin of fish and other information from the QR-Code attached to the MD.
Step 5 - Catch movement to processing plants: In case the catches are purchased and transferred to processing plants for exportation, buyer should record the MD issued by Fishing Port Authority and give to the final buyer/processor for reference.
Step 6 – Request of CC by Processor: In case the catches are processed for export to international market, the processor should submit the request form via web-based application to the Competent Authority (CA). The request form includes information on exportation of fishery products and use of raw materials as reference to the MD, international logistic information, other health certificate and importer information.
Step 7 – Issuance of CC by the Competent Authority (CA): After CA receives the request from processors as mentioned in the Step 6, CA will validate all information for processing and used of raw materials, and all required documents for exportation. In case of any problems or insufficient information, the CA will send notification to the Processor, but if there is no problem on the submitted documents, the CA will issue the CC to the Processor for exportation.
Step 8 - Catch from port directly exported to international market: In this case, the catch will not pass the processing plants but are directly exported to international market, the exporter or seller should request the CC from the Competent Authority
Step 9 - Export of catch or fishery products to international market: Key actors on this process are the exporter and/or processor or seller, and Steps 7 and 8 are followed.
Step 10 - Importer trace the origin of fish: This is the last step for eACDS, where the importer who works closely with their National Customs, is able to trace the fishery products and origin of fish as raw materials through the QR-Code which is attached to the CC and sent together with the fishery products.

eACDS Web-based Application could be accessed at URL: *http://163.44.197.130/eACDS/*. The eACDS Web-based Application refers to the database which is consists of five (5) modules, namely: (1) list of fish species, (2) list of vessels, (3) list of fishing zones/areas, (4) Manage User, and (5) System Setting as shown in **Fig. 2**. In addition, there are eight (8) main menus for implementation of the eACDS. These are: (1) Dashboard Menu: information center that pools all important information together, such as numbers of port-out and port-in, numbers of catch reported to the system, list of fish species

Box 3. Key Data Elements for eACDS				
(1) Point of Catch				
Key Data Element (KDE)	KDEs recommended by WWF	KDEs required for US Imports	KDEs required for EU Imports	KDEs required for eACDS
Scientific Name (species)	X	X	X	X
Common Name (species)		X		X
Local Language Name (species)				X
ASFIS # or 3A-Code (species)		X		X
Estimated Weight (kg)				X
Verified Weight (kg)	X	X	X	X
Location of Catch	X	X		X
Catch Description			X	
Date of Port-out				X
Date and Time of Catch/fishing	X	Date only		Date only
Type of Gear/method used	X	X	X	X
Name of Fisher(s)			X	X
Name of Captain/ fishing master				X
Names and Nationality of Fishing Crew				X
Fishing Company Name		X		X
Fishing Vessel Owner name			X	X
Company Address/contacts		X	X	X
Name of Fishing Vessel	X	X	X	X
Unique Vessel id/ Registration #	X	X	X	X
VMS Unit #			X	X
Vessel Type/ Tonnage (MT)			X	X
Fishing License #	X	X	X	X
Fishing license expiry date				X
Flag State of Vessel	X	X	X	X
Date of port-in/ Landing Port				X
Landing Port name				X
Date, Time, Location of Trans-shipment; Name and Vessel ID of Receiver	X	X		X
IMO/Lloyd's #			X	X
Inmarsat #			X	X
(2) Buyers, Receivers/Suppliers, Sellers (wholesale)				
Key Data Element (KDE)	KDEs recommended by WWF	KDEs required for US Imports	KDEs required for EU Imports	KDEs required for eACDS
Name of Company			X	X
Address of Company				X
Name of Company Owner			X	
Buyer/Receiver/seller registration number/i.d.				X
Description of purchased catch by buyer or receiver	X			X
Verified total weight (kg) of purchased catch	X	X	X	X
(3) Processors				
Key Data Element (KDE)	KDEs recommended by WWF	KDEs required for US Imports	KDEs required for EU Imports	KDEs required for eACDS
On-land Processing Facility:				
Name of Processing Company				X
Address of Processing Company/Plant				X
Registration/License No.		X		X
Batch No.	X	X		X

Box 3. Key Data Elements for eACDS (Cont'd)				
Description of Seafood Processed/ fish products	X	X		X
Fishery Products / HS-Product Code				X
Validation Date (of Processing)				X
Total weight (kg) of Processed Fishery Product	X	X		X
At-sea Processing (Vessel):				
Vessel Name Vessel	X	X		X
License/Regist. #	X			
Catch certificate No.				X
Validation Date (of Processing)				X
Description of Seafood Processed	X	X		X
Total Landed Weight (kg) of Catch				X
Total Weight (kg) of Processed Fishery Product	X	X		X
(4) Exporters and International Shipping/Transport				
Key Data Element (KDE)	KDEs recommended by WWF	KDEs required for US Imports	KDEs required for EU Imports	KDEs required for eACDS
Name and Address of Exporter (Company)		X	X	X
Type of transport (air, sea; carrier type/size)				X
Competent Authority Validation		X	X	X
Certificate of Origin; incl. #				X
Export Declaration Form				X
Bill of Lading				X
Container #				X
Export document #				X
Verified weight (kg)		X	X	X
Gov. catch certificate				X
Gov. health certificate				X
At-sea Export (Vessel):				
Fishing Vessel Name, Registration #		X	X	X
Type and Weight (MT) of Fishing Wessel		X	X	X
Date and Time of Catch		X	X	X
Location of catch		X	X	X
Flag of Home Port		X	X	X
Fishing License #		X	X	X
IMO/Lloyd's #		X	X	X
Inmarsat #		X	X	X
(5) Importers				
Key Data Element (KDE)	KDEs recommended by WWF	KDEs required for US Imports	KDEs required for EU Imports	KDEs required for eACDS
Importer Name (Company)		X	X	X
Address of Importer		X	X	X
Name of Owner or Importing Representative		X	X	X
Import Authority Control/ Validation		X	X	X
Customs Declaration		X	X	X
Gov. catch certificate			X	X
Gov. health certificate		X	X	X
(6) End-consumers				
Key Data Element (KDE)	KDEs recommended by WWF	KDEs required for US Imports	KDEs required for EU Imports	KDEs required for eACDS
List of information and origin of catch via QR Code				X

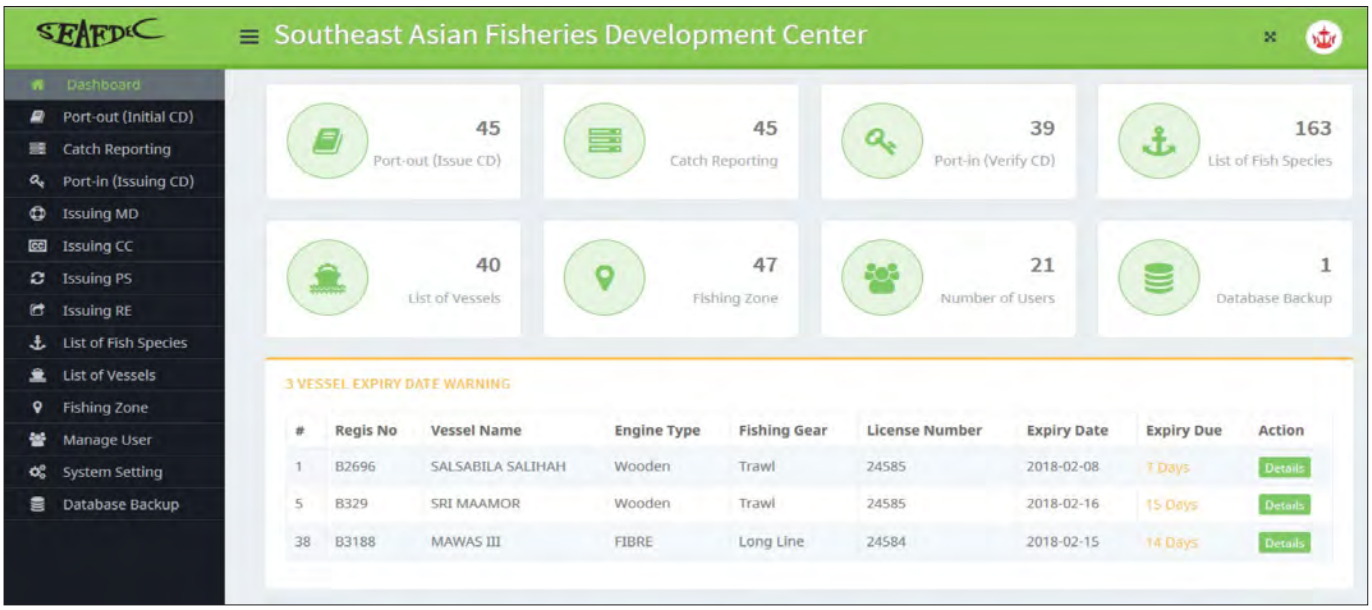

Fig. 2. Web-based Application of the eACDS

in the system, list of vessels, fishing zones, number of users, and database backup; (2) Port-out Menu; (3) Catch Reporting Menu; (4) Port-in Menu; (5) Issue MD Menu; (6) Issue CC Menu; (7) Issue RC Menu); and (8) Issue PS Menu.

Mobile Application of the eACDS

The Mobile Application of the eACDS can be downloaded from Play Store of the Android operating system by opening the Play Store on the mobile devices and type "eACDS" in search textbox and choose eACDS application as shown in **Fig. 3a**; or by opening the browser such as google chrome and then enter *https://play.google.com/store/apps/details?id=org.seafdec.e_acds* (**Fig. 3b**). The eACDS Mobile Application has been developed mainly for relevant users, such as fishing masters, buyers or fisheries agencies, and other concerned stakeholders. In the process of catch reporting onboard fishing vessels or at sea, fishing masters should report their catch by species and weight to the eACDS system via the Mobile Application. In addition, in the process of purchasing/sale of catch at landing sites, the buyers and/or fish agents registered with the Department of Fisheries could also access the Mobile Application. This way, catch data and information could be recorded in all steps of the supply chain for traceability of the fish and fishery products.

VMS Requirements

To ensure that flag State vessels are fishing within the authorized fishing areas/zones and not to engage in IUU fishing activities, it is strongly suggested that Vessel Monitoring System (VMS) is established at country level. Even though the eACDS is designed not to link directly with the VMS, fisheries inspectors in the field or at landing sites

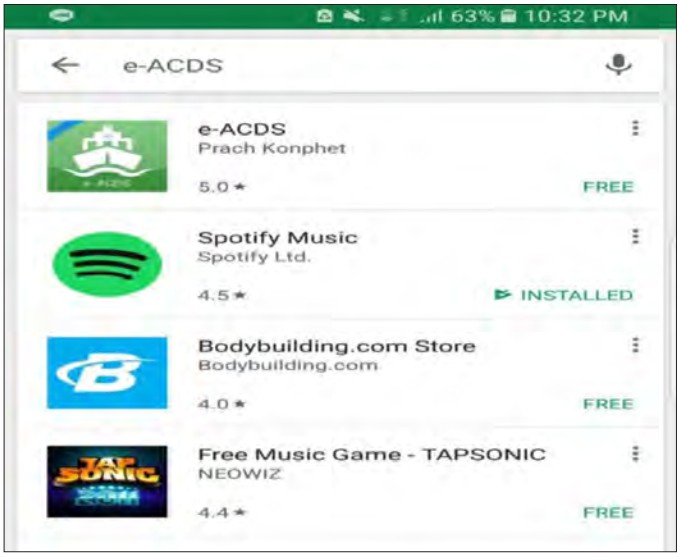

Fig. 3a. eACDS Mobile Application on Play Store

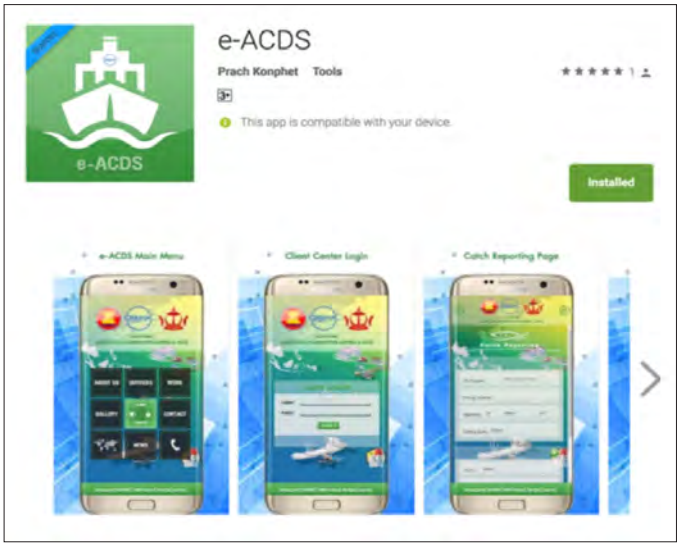

Fig. 3b. eACDS Mobile Application via URL

are able to check and/or monitor the flag State vessels via online devices such (*e.g.* mobile phones, tablets) through the existing VMS. In case a country does not have a VMS in place, validation of the vessel's location could be cross-checked with the Logbooks at the landing sites.

Way Forward

The ACDS is a fisheries management tool for enhancing intra-regional and international trades and is an essential part of the ASEAN Guidelines for Preventing the Entry of Fish and Fishery Products from IUU Fishing Activities into the Supply Chain (Ali *et al*.,2015). As defined in the said Guidelines, the forms of IUU fishing activities occurring in the Southeast Asian region include: (1) illegal fishing activities within a country; (2) unauthorized transshipment and landing of fish/catch across borders; (3) poaching in the EEZs of other countries; (4) illegal fishing and trading practices of live reef food fish, reef-based ornamental and endangered aquatic species; (5) IUU fishing in the high seas and RFMO areas. Therefore, exportation and re-exportation of fish and fishery products, processed or not, caught by AMS flagged fishing vessels within their EEZs, that of other AMS and/or the High Seas, should be accompanied by an ACDS.

The first version of eACDS applications was developed for pilot-testing in Brunei Darussalam. Kick-off implementation of the eACDS has been tentatively set from the 1st Quarter of 2018. Nonetheless, the progress on the development of eACDS had been introduced to all SEAFDEC Member Countries during the Twentieth Meeting of the Fisheries Consultative Group of the ASEAN-SEAFDEC Strategic Partnership in Bangkok, Thailand in November 2017. During such Meeting, SEAFDEC was asked to introduce the system to its Member Countries starting with Viet Nam, Myanmar, Malaysia, Indonesia, and the Philippines. SEAFDEC therefore plans to develop the eACDS for Viet Nam and Myanmar in 2018.

Lastly, considering that the eACDS is designed to meet the requirements of the AMSs and not create unnecessary burden, cost or lengthy process to all supply chain stakeholders, importers and exporters, SEAFDEC will continue to work with its collaborating partners to improve the eACDS. With the eACDS being supported by various electronic formats, the ultimate goal is therefore to ensure that the system is friendly for all stakeholder-users.

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Initiating Resource Enhancement of Seahorses:
A Case Study at Sagay Marine Reserve in Central Philippines

Shelah Mae B. Ursua

Seahorses (*Hippocampus* spp.) are commonly found in tropical coral reefs as well as in lagoons and estuaries, and are highly exploited for their high price, resulting in the listing of these seahorses in the International Union for Conservation of Nature (IUCN). In fact, all seahorses are among the first marine fishes of commercial importance to be listed in both the IUCN and Appendix II of the Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES) to ensure their sustainable utilization. In promoting the protection and sustainability of this resource, efforts have been made worldwide for their conservation through stock enhancement by releasing captive-bred or captive-held seahorses. The SEAFDEC Aquaculture Department (AQD) with support from the Japanese Trust Fund through the project "Resource Enhancement of Internationally Threatened and Over-exploited Species in Southeast Asia through Stock Release," has been working on the resource enhancement of seahorses primarily by developing appropriate release and monitoring strategies, and enhancing the involvement of concerned communities in the management of the natural as well as the restocked seahorses.

Seahorses are vulnerable species due to habitat degradation and pressure arising from illegal, unreported and unregulated collection of these resources for traditional Chinese medicine and to a lower extent, the marine aquarium and curio trade (Vincent *et al*., 2011; Foster *et al*., 2016). Recognizing that the release of captive-bred animals to augment the threatened wild populations needs to be managed carefully to circumvent damages to the wild seahorse populations as results of disease introductions and genetic contamination of the natural population, AQD initiated a baseline assessment of the natural stocks of seahorses in a pilot site in Molocaboc Island in Sagay Marine Reserve, Sagay City, Negros Occidental in central Philippines (**Fig. 1**). Taking into consideration the information compiled during the baseline assessment, AQD carried out the necessary preparatory activities (Vincent and Koldewey, 2006), for the development of long-term program on seahorse stock release and enhancement in the Philippines which could also be applicable in other countries in the region.

Fig. 1. The pilot site in Molocaboc Island, which is part of Sagay City, Negros Occidental, Philippines

Baseline assessment of seahorse natural stocks

In order to establish the baseline information on the wild seahorse population at Molocaboc Island in Sagay Marine Reserve (**Fig. 1**), monthly monitoring of wild seahorses was conducted from October 2012 to December 2017 on a 12,000 m^2 patch reef in Molocaboc Island. Collection of DNA samples was also carried out for the genetic analyses of the wild and hatchery-reared seahorses, to ensure the genetic integrity of the stock release and enhancement programs.

More specifically, the activity carried out by AQD in Molocaboc Island was aimed at developing the appropriate transport and acclimation strategies from seahorse hatcheries to release sites, determining the appropriate size-at-release of seahorses and time of release, developing the appropriate monitoring strategies of the released seahorses, and enhancing the involvement of concerned communities in the management of the natural as well re-stocked resources through their actual participation in the protection and conservation of the coral and sea grass areas which are the natural habitat of seahorses. Results of the baseline survey to determine the natural seahorse stocks density in the pilot site are shown in **Fig. 2**.

For monitoring of the population density, the seahorses were collected during night time by designated local divers at the onset of high tide. After an hour of diving, the collected seahorses were weighed, measured and classified based on the stages of their gonadal development. From the sampled seahorses, the data were recorded that include the average stretched heights measuring 12.3 ± 0.6 cm, and average body weight at 7.7±1.2 g. Analysis of the data indicated that the average number of seahorses (30 ± 6 ind/sampling) was the same in 2016 and 2017, but was higher than in 2015 (19 ± 6 ind/sampling) and October 2012 to December 2013 (5 ± 3 ind/sampling).

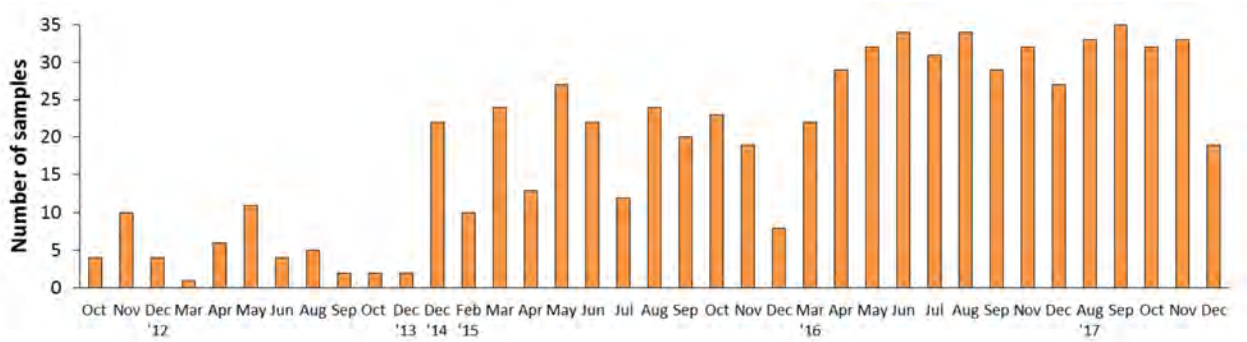

Fig. 2. Monthly data on the number of wild seahorses in Molocaboc Island, Sagay Marine Reserve, Philippines (2012-2017)

As shown in **Fig. 2**, the trend of the natural seahorse stocks in 2016-2017 was increasing, compared with that of the previous years (2012-2015). This suggests that the natural population of seahorse could recover through proper management of the natural resources, particularly by minimizing human disturbance on their habitats and preventing the collection of seahorses. Nevertheless, the average number of seahorses in December 2017 (30 ind or 0.0025 m^{-2}) was much lower than the reported (0.02 m^{-2}) average density of seahorses in Bohol Province, also in central Philippines (Martin-Smith *et al*., 2004). Perante *et al*. (2002) and Morgan and Lourie (2006) gathered that fishers in Bohol reported a decline in the population density of seahorses, especially the tiger tail seahorse *Hippocampus comes*. Specifically, the mean density of seahorse around Jandayan Island on the north-western edge of Bohol, was low at 0.019 m^{-2}, and in nearby islands (also under the jurisdiction of Bohol Province) the densities were even lower at 0.00143 m^{-2} (Perante *et al*., 2002; Morgan and Vincent, 2007). Moreover, Morgan and Lourie (2006) also reported a decline in the mean catch per unit effort (CPUE) throughout central Philippines, *i.e.* 24 seahorses per night per fisher in 1986-1990 to 2.9 seahorses per night per fisher in 1996-1999.

Natural food such as mysids and copepods are abundant in the pilot site area, which explains the all year round presence of sexually mature seahorses. Analysis of the stages of their gonad development also indicated that partially and fully mature development of the gonad of males and females could occur throughout the year (**Fig. 3**).

Population density monitoring strategies

For the density monitoring of seahorse population, the local divers had to undergo training on the proper handling of live seahorses, conducted by AQD researchers. More particularly, practical lectures were given to the divers for them to learn the skills and techniques of handling live seahorses during sampling to minimize stress on the animals, including the proper use of PVC pipes that temporarily hold the seahorse samples (**Fig. 4**).

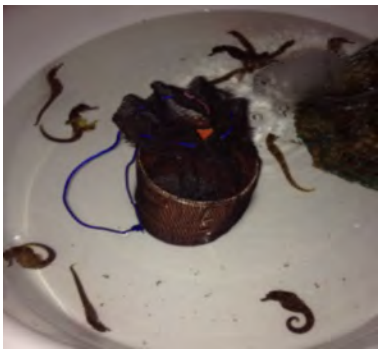

Fig. 4. PVC pipes used as temporary holding for seahorses

The informal lectures given to divers also included the biology of seahorses to enable them to efficiently collect the necessary measurements of the stretched height and body weight, as well as information on the stages of gonadal development of the sampled seahorses. Furthermore, hands-on training on monitoring of seahorses was also regularly conducted by AQD researchers for the fisherfolk organization members in

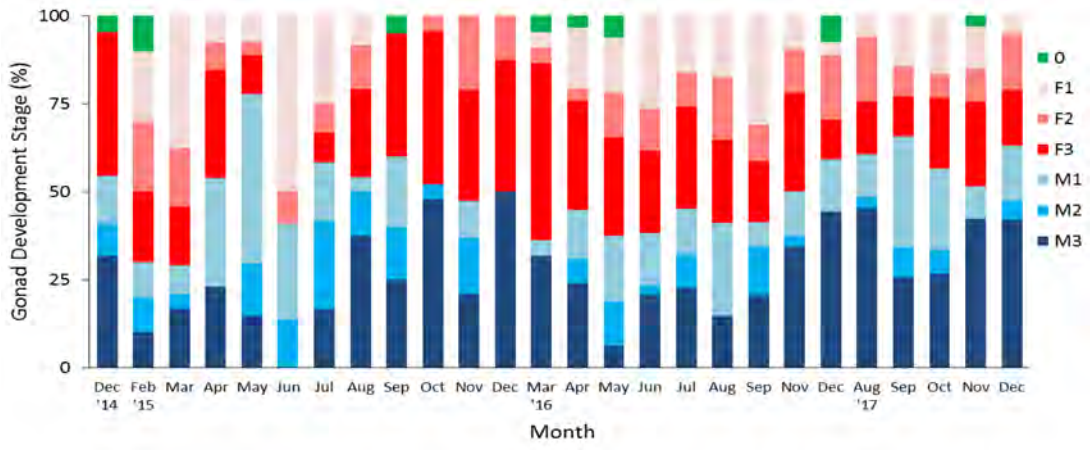

Fig. 3. Gonad development stage of wild seahorses observed from December 2014 to December 2017 Legend: **0** - juvenile, **F1** – immature female, **F2** - partially mature female, **F3** – fully mature female, **M1** – immature male, **M2** – partially mature male, **M3** – fully mature male.

the pilot site, for them to provide assistance in the monitoring of the seahorses when needed.

Transport of seahorses from hatcheries to release site

Trials on transport and acclimation were conducted with three replicates for each of the three size groups of juvenile seahorses (**Fig. 5**): **size A** – 5 cm stretched height, **size B** – 6 cm SH and **size C** – 7 cm SH. A styrobox was filled with seawater and oxygenated. Nylon twines tied to lead sinkers were provided as holdfast for seahorses. Stocking densities of 1, 2, 3, 4 and 5 ind/L and transport durations of 10 and 12 hours were tested on the juvenile seahorses. The 7-day post-transport survival of seahorses was observed using intermediate enclosures made of black nets (1x1x1 m^3) and plastic cylindrical screen cages (30 cm long, 25 cm diameter) hanged on a 5 x 5 m^2 floating bamboo raft.

Fig. 5. Measuring of seahorse to determine size-at-release

Using such information for transporting the seahorses, there was 100% survival of the seahorses upon arrival in Molocaboc Island, for all size groups at all stocking densities for the 10 and 12-h transport duration. However, after 7 days of observation, only those with stocking densities of 1, 2 and 3 ind/L for all three size groups showed 100% survival. As a result, the survival for all size groups ranged at 70-85% and 50-60% for the transport stocking densities of 4 and 5 ind/L, respectively. The result also suggested that the optimum stocking density for transport should be 3 ind/L for 5-7 cm SH seahorse juveniles for a 12-h transport duration.

Community-based hatchery for seahorses

A community-based hatchery facility in Molocaboc Island was constructed to establish a technique for seahorse hatchery using the available natural food for seahorses in the area. Pregnant male seahorse breeders were collected from the patch coral reef and transferred to 10-L plastic pails at stocking density of 1 ind/5 L (**Fig. 6**). Mild aeration was provided using solar-powered aerators. Pail bottom was siphoned daily at 30-50% water change.

Fig. 6. Juvenile seahorses reared in 10L plastic pail

The breeders were released again in coral reef area after parturition (giving birth). Natural food was collected during night time at the sampling site using plankton net. Mysids and copepods were separated using a sieve with 40 µm plankton net. Mysid shrimps were fed to the adult seahorses, while copepods were fed to newborn seahorses. Stocking density for the newborn seahorses was ~100/10 L plastic pail. Feeding was *ad libitum*.

Information, education and communication

Using the information compiled through the baseline assessment and the resource enhancement activity, information, education and communication (IEC) has been promoted through the conduct of lectures on the biology, resource management and baseline data of wild seahorse population in Molocaboc Island. IEC campaign on the management of natural resources highlighting on the seahorse biology and conservation has been conducted yearly in Molocaboc Island since 2015.

Attended by students, school teachers, fishermen organization members, and local government officials, the event on 22 November 2017 also included a Draw and Tell Contest with the theme "My role in the promotion of seahorse as a natural resource in my community" (**Fig. 7**). A total of twenty (20) students, 10 from the elementary and 10 from the secondary level of Molocaboc Integrated School, participated in the said

contest. Their art works which showed seahorse in corals and sea grasses, also exhibited the importance of protecting the natural habitat of seahorses to safeguard the dwindling population of seahorses in the wild (**Fig. 8**).

Fig. 7. Two of the students of Molocaboc Island creating their entries to the "Draw and Tell Contest" which aimed to promote seahorse as a natural resource in the community

Fig. 8. Finished art works of the students joining the "Draw and Tell Contest"

Way Forward

Future activities on stock release and resource enhancement of seahorses require not only the results of baseline assessment of the natural stocks including genetic characterization of the wild stocks, but also the established appropriate size-at-release of the animals appropriate for the monitoring strategies. It is expected that the appropriate release strategies for hatchery-reared juveniles could enhance the recovery of the seahorse population and density, as well as the participatory involvement of the concerned communities. Promotion of IEC is also crucial to assess the perception of the communities towards seahorse stock release and resource enhancement. At the national and regional levels, and for the long-term sustainability of the seahorse resources, the relevant information derived from the activities at the pilot site in Molocaboc Island, Sagay City, Negros Occidental could be used to promote the resource enhancement of seahorses not only in other potential sites of the Philippines but also in other countries of the Southeast Asian region.

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CALENDAR OF EVENTS

Date	Venue	Title	Organizer(s)
		2018	
23-25 January	Binh Dinh, Viet Nam	On-site Training Course on Proper Fish Handling Techniques Applicable to Local Fishing Vessels	SEAFDEC/TD
25 January	Bangkok, Thailand	1st Regional Meeting for the Project on Enhancing Sustainable Utilization and Management Scheme of Tropical Angullid Eel Resources in Southeast Asia	SEAFDEC Secretariat
5-9 February	Rizal, Philippines	Training Course on Freshwater Prawn Hatchery and Grow-out Operations	SEAFDEC/AQD
6-9 February	Thailand	Workshop on Gender Analysis in Fishery Management in Coastal Communities in Cambodia, Myanmar and Thailand	SEAFDEC/TD
7-9 February	Rome, Italy	FIRMS-Global Record of Stocks and Fisheries (GRSF) Technical Working Group Meeting	FAO/FIRMS
19-23 February	Rizal, Philippines	Training Course on Catfish Hatchery and Grow-out Operations	SEAFDEC/AQD
20-23 February	Bangkok, Thailand	Regional Training on Port State Measures Implementation in Southeast Asia	SEAFDEC/TD
21-24 February	Kota Kinabalu, Malaysia	Practical Workshop on Tuna Stock Assessment for Yellowfin Tuna, Bigeye Tuna and Skipjack Tuna Resources in Sulu-Sulawesi Seas by CPUE Standardization, ASPIC, and Kobe Plot (Stock Status Trajectory Plot)	SEAFDEC/TD
12-16 March	Rizal, Philippines	Training Course on Tilapia Hatchery and Grow-out Operations	SEAFDEC/AQD
13-14 March	Bangkok, Thailand	Technical Experts Meeting on Management of Transboundary Species for the Norther Andaman Sea	SEAFDEC Secretariat
13-14 March	Bangkok, Thailand	ASEAN Regional Forum on Sustainable Fisheries Management and Food Security in Southeast Asia	Thailand & ASEAN
19-23 March	Denarau, Fiji	27th Session of the Asia and Pacific Commission on Agricultural Statistics	FAO/RAP
20-22 March	Louangphrabang, Lao PDR	14th Meeting of the ASEAN Working Group on the Convention on International Trade in Endangered Species of Wild Fauna and Flora	Lao PDR & ASEAN
20-22 March	Brunei Darussalam	Terminal RTC for the Project on Enhancing Coastal Community Resilience for Sustainable Livelihood and Coastal Resources Management	SEAFDEC/ MFRDMD & IDB
21-22 March	Bangkok, Thailand	8th Meeting of the ASEAN Shrimp Alliance (ASA)	Thailand & ASEAN
26-30 March	Siem Reap, Cambodia	50th Meeting of the SEAFDEC Council	SEAFDEC
4-5 April	Louangphrabang, Lao PDR	14th Meeting of the ASEAN Working Group on the Convention on International Trade in Endangered Species of Wild Fauna and Flora	Lao PDR & ASEAN
4-5 April	Bangkok, Thailand	Technical Experts Meeting on Management of Transboundary Species for the Southern Andaman Sea	SEAFDEC Secretariat
5-20 April	Iloilo, Philippines	Training Course on Sandfish *Holothuria scabra* Seed Production, Nursery and Management	AQD
9-13 April	Nadi, Fiji	34th FAO Regional Conference for Asia and the Pacific	FAO/RAP
16-20 April	Rizal, Philippines	Training Course on Carp Hatchery and Grow-out Operations	SEAFDEC/AQD
18-19 April	Singapore	End-of-Project Meeting on Cold Chain Management of Seafood	SEAFDEC/MFRD
24-25 April	Da Nang, Vietnam	Bilateral Technical Meeting on Effective Fisheries Management between Thailand and Viet Nam	SEAFDEC Secretariat
14-18 May	Rizal, Philippines	Training Course on Freshwater Prawn Hatchery and Grow-out Operations	SEAFDEC/AQD
18-22 June	Rizal, Philippines	Training Course on Tilapia Hatchery and Grow-out Operations	SEAFDEC/AQD
19 June-25 July	Iloilo, Philippines	Training Course on Marine Fish Hatchery	SEAFDEC/AQD
13-17 August	Rizal, Philippines	Training Course on Tilapia Hatchery and Grow-out Operations	SEAFDEC/AQD
8-10 October	Kuala Lumpur, Malaysia	Core Expert Meeting on Data Collection, Taxonomy, Biology, Marketing and Trade of Sharks and Rays in the Southeast Asian Region	SEAFDEC/ MFRDMD
23-25 October	Kuala Lumpur, Malaysia (TBC)	4th Core Expert Meeting on Comparative Studies for Management of Purse Seine Fisheries in the Southeast Asian Region	SEAFDEC/ MFRDMD
5-7 November	Langkawi, Malaysia	41st SEAFDEC Program Committee Meeting (PCM)	SEAFDEC
8-9 November	Langkawi, Malaysia	21st Meeting of the Fisheries Consultative Group of the ASEAN-SEAFDEC Strategic Partnership (FCG/ASSP)	SEAFDEC

Southeast Asian Fisheries Development Center (SEAFDEC)

What is SEAFDEC?

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

Mandate

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

Objectives

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

SEAFDEC Program Thrusts

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


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The second prize drawing winner, *Aubrey Beatrice Carnaje*, from the national drawing contest in Philippines

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