FISH for the PEOPLE

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

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SEAFDEC beyond 2017:
Aiming for enhanced sustainability of marine fishery resources

Southeast Asian Fisheries Development Center

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Editorial

Alongside the signing of the Agreement Establishing SEAFDEC during the Inaugural Meeting of the SEAFDEC Council in March 1968, the SEAFDEC Council agreed to establish the Marine Fisheries Training Department (TD) to address the shortage of fishing vessel officers such as fishing masters and marine engineers capable of directing fishing operations or operating medium-sized boats, which at that time was a major constraint in the development of the region's fisheries. Hosted by the Royal Government of Thailand, TD was formally established in 1968 in Samut Prakan, Thailand, with the original functions of: training fisheries technicians of the Southeast Asian countries in various aspects of modern marine fisheries, engineering and navigation techniques; and undertaking studies on the types of fishing gears and methods suitable to the fisheries in Southeast Asia.

With significant paradigm shift in the region's fisheries development in the mid-70s and the establishment of the Marine Fishery Resources Development and Management Department (MFRDMD) later in 1990 in Terengganu, Malaysia, TD refocused its role towards promoting responsible fishing practices and modern fishing technologies for better utilization of the region's fishery resources while MFRDMD has been tasked to assist the Member Countries in the development and management of marine fishery resources in the waters of the Southeast Asian region. Since then, TD and MFRDMD continued to enhance and rationalize their respective programs of work on the sustainable management as well as effective and rationale utilization of the available fishery resources in the Southeast Asian region.

In conjunction with the celebration of the 50th Anniversary of SEAFDEC in 2017, the SEAFDEC Council of Directors during the Special Council Meeting convened on 15 November 2017, adopted the "Resolution on the Future of SEAFDEC: Vision, Mission and Strategies Towards 2030." Guided by such instrument and while continuing their thrusts towards enhanced sustainability of the region's marine fishery resources, TD and MFRDMD are aligning their R&D programs with the revitalized SEAFDEC Vision of boosting the "Sustainable Management and Development of Fisheries and Aquaculture to Contribute to Food Security, Poverty Alleviation and Livelihood of People in the Southeast Asian Region," which forms part of the Resolution on the Future of SEAFDEC that serves as guide for SEAFDEC in planning its programs of work. Nonetheless, the articles presented in this issue of *Fish for the People* could also help TD and MFRDMD in their planning and programming efforts.

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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.

Call for Articles

FISH for the PEOPLE is a policy-oriented special publication of SEAFDEC. Now on its 16th year, the Publication is intended to promote the activities of SEAFDEC and other relevant fisheries concerns in the Member Countries. We are inviting contributors from the SEAFDEC Departments, Member Countries, and partner organizations to submit articles that could be included in the forthcoming issues of the special publication. The articles could cover fisheries management, marine fisheries, aquaculture, fisheries postharvest technology, fish trade, gender equity in fisheries, among others. Written in popular language and in layman's terms for easy reading by our stakeholders, the articles are not intended to provide detailed technical and typical scientific information as it is not a forum for research findings. Please submit your articles to the Editorial Team of Fish for the People through the SEAFDEC Secretariat at *fish@seafdec.org*. The article should be written in Microsoft Word with a maximum of 10 (ten) pages using New Times Roman font 11 including tables, graphs, maps and photographs.

Re-aligning SEAFDEC Programs Towards Enhanced Sustainability of Southeast Asian Fisheries: **Resolution on the Future of SEAFDEC**

Kom Silapajarn and *Virgilia T. Sulit*

The Southeast Asian Fisheries Development Center (SEAFDEC) was established in December 1967 to promote fisheries development in Southeast Asia for the improvement of the food situation in the region. Prior to such event, the First Ministerial Conference for Economic Development of Southeast Asia in April 1966 considered the proposal to establish a "Marine Fisheries Research and Development Center" in Southeast Asia to serve as platform for the promotion of fisheries as means of improving the food situation in Southeast Asia. Upon thorough review of the said proposal, the Second Ministerial Conference for Economic Development of Southeast Asia in April 1967 adopted the proposal, paving the way for the crucial period in the evolution of SEAFDEC, which has now 11 Member Countries, namely: Brunei Darussalam, Cambodia, Indonesia, Japan, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam. SEAFDEC operates through its Secretariat and five Technical Departments, each with specific functions and mandate. The Secretariat in Bangkok, Thailand, is tasked to oversee the general policy and planning of the Center; the Training Department (TD) in Samut Prakan, Thailand to promote responsible fishing technologies and coastal fisheries management for responsible resources utilization and sustainable livelihoods; Marine Fisheries Research Department (MFRD) in Singapore to promote, undertake and coordinate research and development activities on fisheries post-harvest technology and practices; Aquaculture Department (AQD) in the Philippines to carry out activities in aquaculture research, technology verification, training and information dissemination on a wide range of aquaculture disciplines; Marine Fishery Resources Development and Management Department (MFRDMD) to conduct R&D activities on marine fishery resources assessment and management; and the Inland Fishery resources Development and Management Department (IFRDMD) in Indonesia to carry out R&D activities that support the sustainable development and management of inland capture fisheries. Each Department has its own Program of Work which is reviewed regularly to take into consideration the requirements and priorities of the SEAFDEC Member Countries. Development of the Programs of Work also takes into consideration the need to address the issues and concerns brought about by the changing environment of the Southeast Asian fisheries as reflected in the Resolutions and Plans of Action adopted by the Ministers and Senior Officials of the ASEAN-SEAFDEC Member Countries, the latest of which is the "Resolution on the Future of SEAFDEC: Vision, Mission and Strategies Towards 2030," to be used by SEAFDEC in developing its programs of work beyond its 50th year of working towards the sustainable development of fisheries in the Southeast Asian region.

On the occasion of the celebration of the 50th Anniversary of SEAFDEC in 2017, the SEAFDEC Council of Directors convened a Special Meeting in November 2017 to map the future direction of SEAFDEC beyond its 50 years of existence in the region. The "Resolution on the Future of SEAFDEC: Vision, Mission and Strategies Towards 2030" that the SEAFDEC Council adopted during the said Special Meeting (SEAFDEC, 2018), would serve as guide for SEAFDEC in developing its future programs of work that aim to enhance the utilization of the region's fishery sources for the sustainability of the region's fisheries.

The Resolution on the Future of SEAFDEC was developed based on the recommendations of the SEAFDEC Program Committee during its Thirty-ninth Meeting in 2016 and noted by the SEAFDEC Council of Directors during its Forty-ninth Meeting in 2017. As agreed during these meetings, the future direction of SEAFDEC beyond its 50th year, should hinge on the said Resolution to be adopted by the SEAFDEC Council through a Special Meeting, to be convened in conjunction with the celebration of the Fiftieth Anniversary of SEAFDEC. While before, planning of the programs and activities of SEAFDEC had been structured in accordance with the SEAFDEC Program Framework and Program Thrusts that had been endorsed in 2000s by the SEAFDEC Council, henceforth, the programs and activities would be restructured to take into consideration the revitalized Vision and Mission of SEAFDEC as well as the Strategies for Sustainable Development of Fisheries towards 2030 that form part of the Resolution on the Future of SEAFDEC.

Reference

SEAFDEC. 2018. Report of the Special Meeting of the Southeast Asian Fisheries Development Center, 15 November 2017, Bangkok, Thailand, Southeast Asian Fisheries Development Center, Bangkok, Thailand; 25 p

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Resolution on the Future of SEAFDEC:
Vision, Mission, and Strategies Towards 2030

(Adopted on 15 November 2017 at the Special Meeting of the SEAFDEC Council)

We, the Council Directors of SEAFDEC during our Meeting in Bangkok, Thailand on the occasion of the Special Meeting of the SEAFDEC Council on 15 November 2017 organized in conjunction with the 50th Anniversary of SEAFDEC,

Recognizing that provisions in various international instruments such as the United Nations Convention on the Law of the Sea (UNCLOS, 1982), the UN Sustainable Development Goals (SDG, 2015), the FAO Code of Conduct for Responsible Fisheries (CCRF, 1995), and relevant International Plans of Action are crucial for the development of programs and activities towards enhancing the practices for sustainable fisheries development in the Southeast Asian region;

Affirming the need to implement actions in line with regional fisheries policy frameworks, particularly the Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region adopted by the ASEAN-SEAFDEC Ministers and Senior Officials responsible for fisheries during the ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2020 "Fish for the People 2020: Adaptation to a Changing Environment" in June 2011;

Also affirming the need to support the Member Countries of SEAFDEC in the implementation of regional guidelines and policy recommendations developed by the SEAFDEC in collaboration with the Member Countries;

Bearing in mind the need to enhance cooperation with ASEAN under the ASEAN-SEAFDEC Strategic Partnership (ASSP) framework, support the implementation of activities under the ASEAN-SEAFDEC Fisheries Consultative Group (FCG) mechanism, and take into consideration the "Strategic Plan of Action on ASEAN Cooperation in Fisheries (2016-2020)"; and

Recognizing the need for SEAFDEC to continue playing an active role in enhancing the collaboration among the Member Countries, as well as partnerships with prominent regional, international organizations and donor agencies towards the sustainability of fisheries and aquaculture in the Southeast Asian region;

Being aware the fact that regional guidelines and policy recommendations and frameworks developed under different organizations, mechanism and arrangements beyond Southeast Asian region need to be taken into account; and

Resolved to adopt the Vision, Missions, and Strategies of SEAFDEC towards 2030, as follows:

I. VISION

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

II. MISSION

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

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

III. STRATEGIES

1) Securing the sustainability of fisheries to contribute to food security, poverty alleviation and livelihood of people in the region:

- Assessment of important marine fish stocks in the region and development of guidelines of management measures for such fish stocks;
- Assessment of the status of inland fisheries, and compilation of baseline information on policies and regulations related to inland fisheries in the Member Countries;
- Compilation of scientific data and information including local knowledge on both inland and marine fisheries to support policy formulation and management for sustainable fisheries;
- Development and promotion of regional measures and tools for combating IUU fishing;
- Development of innovative management tools and concepts that are applicable for fisheries in the region;
- Development and promotion of responsible fishing technologies, including energy optimization, carbon reduction and reduction of post-harvest losses onboard fishing vessels; and
- Integration of habitat and fisheries management, and provision of support for the conservation of important fishery resources.

2) Supporting the sustainable growth of aquaculture to complement fisheries and contribute to food security, poverty alleviation and livelihood of people in the region:

- Development, verification and promotion of responsible and sustainable aquaculture technologies, to improve the quality of broodstocks and technologies on seeds production;
- Finding alternatives to fish meal in feed formulation and promote economical use of feeds;
- Development of practical fish health management strategies including the establishment of early warning system for aquatic animal diseases;
- Generation of appropriate technologies for rural aquaculture to provide livelihood and alleviate poverty; and

- Compilation of scientific data and information including local knowledge to support policy on sustainable aquaculture.

3) **Ensuring the food safety and quality of fish and fishery products for the Southeast Asian region:**
   - Development and promotion of technology to produce high quality, healthy and safe fish and fishery products to meet the international standards;
   - Improving endogenous processing technologies to standard or acceptable levels;
   - Regular monitoring of chemical and biological contaminants to ensure seafood safety; and
   - Promotion of seafood quality assurance systems for fish processing establishments in the region.

4) **Enhancing trade and compliance of the region's fish and fishery products with market requirements:**

   - Strengthening the cooperation among Member Countries to implement international standards in trade of fish and fishery products within the ASEAN region;
   - Development of regional standards, policies and guidelines to enhance intraregional/international trade; and
   - Development and promotion of traceability system for fish and fishery products in the region.

5) **Addressing cross-cutting issues, such as labor, gender and climate change, where related to international fisheries:**

   - Provision of platforms for monitoring and evaluating the impacts of emerging international fisheries-related issues on the fisheries and economic sectors in the region;
   - Organizing fora to enhance the awareness of Member Countries on international fisheries-related issues and coordinating the development of the ASEAN Common Positions to address the regional concerns on the issues;
   - Monitoring of the possible impacts of and raising awareness on climate change to fisheries and aquaculture, and development of adaptation and mitigation measures in response to such impacts;
   - Development regional initiatives to promote the consideration of environmental and biodiversity conservation issues in fisheries and aquaculture management; and
   - Recognition of the importance of small-scale fisheries, welfare of labor in fisheries, safety at sea, and gender equality in the fisheries and aquaculture sector.

6) **Empowering SEAFDEC to strengthen its roles in the region and to improve its services to Member Countries:**

   - Strengthening SEAFDEC's capacity to support ASEAN's efforts to adopt and implement regional policies and guidelines, as well as ASEAN's efforts to monitor the implementation of such regional policies and guidelines;
   - Enhancing the human resource capability of the Member Countries to support, adopt and nationalize regional policies and guidelines;
   - Expanding the network with prominent organizations in relevant fields and engaging actively in international fisheries fora;
   - Enhancing human resources within SEAFDEC organization and pooling expertise in the region to improve the performance of SEAFDEC; and
   - Promoting SEAFDEC to wider international communities to gain more supports from organizations, governments and donors.

Addressing the Legislative Gaps in the Implementation of Port State Measures: Southeast Asian Perspective

Poungthong Onoora

The Port State Measures Agreement (PSMA) adopted by FAO in 2009 is a legally-binding instrument for combating illegal, unreported and unregulated (IUU) fishing in the world. Although only three of the Southeast Asian countries (*i.e.* Indonesia, Myanmar and Thailand) have so far acceded to and/or ratified the PSMA, the other countries have been taking steps and making necessary preparations for ratification, notwithstanding the ongoing efforts of the countries to adopt their respective national port State measures (PSM) as means of controlling IUU fishing in their waters. In order to address some legislative gaps while some of the Southeast Asian countries are still pursuing the possible accession to and/or ratification of the PSMA, still some countries are encountering certain difficulties in implementing the PSMA. With the main objective of overcoming such constraints, this article therefore suggests possible options that could address the issues that arise from the adoption of the PSMA. Such options could include: (1) establishment and/or adjustment of specific national laws that would ensure the involvement of relevant agencies in the implementation of PSM; (2) identification of the ways and means of providing legal assistance to Southeast Asian countries to overcome certain regulatory constraints in the implementation of the PSMA; and (3) development of a model that would address the common concerns in the implementation of the PSM.

Elucidation of Relevant Excerpts from the Port State Measures Agreement

Governance of the world's fisheries and aquaculture is a challenge that involves actors working across different sectors, and requires improved actions and synergies at the global level. In pursuit of sustainable development, wide spectrum of treaties, agreements, and instruments had been formulated and enforced to reconcile the three pillars of development: sustainability of natural resources, social equity, and economic development (Nathiesen, 2017). The international legal framework for ocean governance is made up of a multitude of global, regional and bilateral binding and voluntary instruments, and the key instruments have progressed to address prominent and emerging fisheries challenges having been influenced by the ongoing evolution of global milestones (Nathiesen, 2017). Unfortunately, IUU fishing has increasingly created very complicated problems which could not be solved by using single tools or single *ad hoc* approaches. Therefore, port State measures (PSM) were established and introduced as effective tool to combat IUU fishing at the global, regional and national levels.

The general intention of the Port State Measures Agreement (PSMA) is for the States to make adjustments in their national legislations to be able to implement the PSM, especially in their national policies, laws and institutional frameworks as well as in Monitoring, Control and Surveillance (MCS), operations, procedures, and other regional mechanisms. In terms of policy, the implementation of the PSMA requires an approach that includes policy decisions, legal review and operational procedures. Consequently, decisions taken in these three areas could affect the institutional arrangement necessary to support its effective implementation. States should therefore move forward in a coherent manner, with policy as the driver and guide, but should first take decisions on broad policy matters that affect how their legislation and institutional arrangements would be structured and what should such arrangements contain. Policies can also provide a strong support to the implementation of actions by prioritizing them with respect to national and sectorial agenda. With inter-agency cooperation within the State, implementation of PSMA could address the concerns related to IUU fishing (Kuemlangan, 2017).

On the legal aspect, implementation of the PSMA assumes that States would make some legal adjustments to warrant conformity and strong linkages between national frameworks and the PSMA contents. This could include the development of national legislations necessary for the effective implementation of the PSM based on their respective national fisheries laws and regulations (Onoora, 2008).

At the institutional level, implementation of the PSMA assumes that the States would develop or improve their institutional capabilities in general (human, financial, technological) and strengthen the cooperation (*e.g.* by developing inter-agency agreements, information sharing mechanisms) among national agencies and other States, *i.e.* port, flag, coastal, and market States. In order that countries can implement the PSMA, some aspects in the PSMA should be clarified as indicated in **Box 1**.

Box 1. Relevant excerpts from the PSMA that need clarifications to enable the countries to implement the PSMA

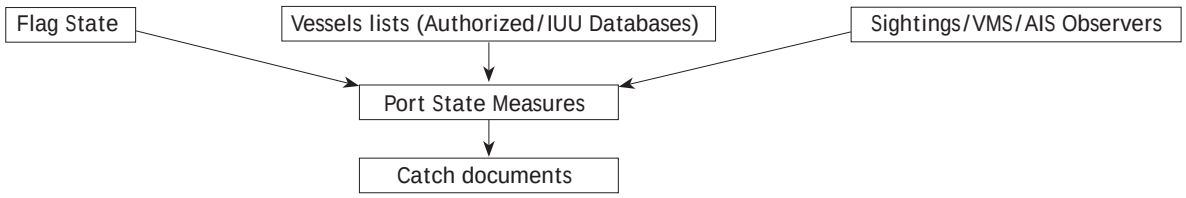
Key Elements of the PSMA

The PSMA was entered into force on 5 June 2016. As of October 2017, there were 51 Parties to the Agreement.

Framework -General

- Elaboration on the information requirements for vessel reporting and inspection reports
- Required reports/information to be transmitted
- Guidelines for inspections and training of inspectors
- Elaboration on the role of Parties as flag States
- Possible assistance for developing States
- Minimum standards for global harmonization of port State measures with strong economic and legal impacts on IUU fishing vessel operators

Linkages: PSM and other key Monitoring, Control and Surveillance (MCS) tools (Swan, 2017)



Example: Roles and Activities of RFMOs in the PSMA

- Tools for assessment of evidence of IUU fishing such as IUU/Authorized Vessel Lists and reporting, and Catch Document Scheme (CDS)
- Communication and notification requirements at all stages (entry, inspection, denial of use)
- Procedures to be developed by RFMOs for identification of "ports of non-compliance"

Example: Impact of PSMA on RFMOs

- Strengthened operations, improved cost-effectiveness
- Strengthened linkages, *i.e.* comprehensive MCS system
- RFMO port State measures are binding on members
- Support for developing State members
- Ratify this agreement and strengthen RFMO measures
- Implementation – Integration in several relevant areas of work in
  - Legislation
  - Procedures
  - Interagency cooperation
  - Capacity Building
  - Strengthen Information and Communication Systems
  - Strengthen flag State measures
- Support ongoing assessment and implementation of port State measures at all levels

Basic Framework for the Implementation of PSMA

The basic framework for implementing PSMA consists of nine (9) major actions:

(1) Definitions (Art. 1 of PSMA)

The relevant concerns in the implementation of the PSMA could include:
1) Are some core definitions such as "vessels," "fishing related activities" consistent with the provisions of PSMA?
2) Are all the relevant definitions included in the national legislations?
3) Definition should be based on national laws, but should also be understandable among law enforcers.
The abovementioned concerns are some of the main topics to be analyzed and discussed among authorities concerned.

(2) Designated Ports (Art. 7 of PSMA)

Designation of Ports is a key element for the implementation of the PSMA and is the main issue that should be covered by the national laws of each State to achieve the aforementioned provision of the PSMA.

(3) Requirements for Port Entry/use (Art. 8 to 11 of PSMA)

- *Foreign vessels must be obliged to request entry and provide the required information.*
  "How far in advance should the information required be provided?" This issue is still differently implemented in each port State because of different national legislations required.
- *Port State must issue written authorization.*
  "Is there a requirement in law for the vessel to present the authorization?
- *Vessel (or agent) must be obliged to present an authorization upon arrival.*
  Denial of port entry: according to the PSMA, Denial of Use of Port after Entry is a key element in the implementation of the PSMA (Kuemlangan, 2008). However, the Party should ensure that the legal power to Denial of the Use of Port AFTER ENTRY in the following cases, are in place. It should also be noted that in these cases, no inspection is required.
  - When there are No Authorization by flag State and/or coastal State
  - Where there is CLEAR evidence of violations within the waters of a coastal State
  - When there are NO confirmation from the flag State, when requested
  - When there are Reasonable Grounds to believe that vessel is involved in IUU fishing, unless rebutted by the vessel operator

Box 1. Relevant excerpts from the PSMA that need clarifications to enable the countries to implement the PSMA (Cont'd)

(4) Denial of Port Entry (Art. 9 of PSMA)
Vessels must be denied port entry where there is sufficient proof of IUU fishing, including proof whether it is on an RFMO IUU Fishing Vessel List.
"Is there power in the national legislation to deny entry?"
"How is this determined through "sufficient proof"?
The PSMA requires the State to have provisions in its law to ensure it has the legal power to deny the use of port after entry, when AFTER INSPECTION there are reasonable grounds to believe that IUU fishing has taken place.

(5) Denial of Port Use after Entry-no inspection required (Art. 11 of PSMA)
This legal action for denying of port use after entry will be enforced with the following cases:
- No authorization by flag State and/or coastal State
- Clear evidence of violations within the waters of a coastal State
- No confirmation from the flag State, if requested
- Reasonable grounds to believe IUU fishing has taken place, unless rebutted by the vessel operator

Denial of use of port after entry-following an inspection (Art. 12) applies when a vessel has already been inspected and there are reasonable grounds to believe that IUU fishing has taken place. However, the question would arise whether or not "there are legal powers in national legislations to act when there is enough evidence as mentioned earlier?" Another question is whether or not "there are adequate penalties in place for violators?"
Note: "in place" means the necessary provisions are available in the national legislations of port State.

(6) Inspection Procedures and Results (Art. 13 and Art.14 of PSMA)
After completing all the procedures for inspection, the report of inspection results must be provided by the port State concerned. However, some questions may arise:
"Does the entity have a clear process of determining the priority of inspection?"
"Is there a requirement to produce reports of inspection consistent with Annex C: Regarding Report of Results of Inspection based on the PSMA?"

(7) Transmittal of Inspection Results (Art.15 of PSMA)
The PSMA requires a port State to provide transmittal of inspection results to flag State, coastal States, national State of master RFMOs. Nevertheless the question would be raised whether "It is a requirement under the national law (of port State) to transmit the results of inspections to those relevant States?

(8) Penalties – To assess the effective implementation of the PSMA, it is important to update the penalties enforced and make the necessary adjustments to ensure adequate penalties for illegal use of ports by foreign vessels and assistance in the use of port by suppliers, among others, where use of port has been denied (Kuemlangan, 2017).

(9) Integration and Coordination – Subject to integration and coordination among authorities from various governmental agencies concerned, the core operational factors/issues could include the following:
- Cross-authorization to officers for fisheries enforcement
- MOUs and other arrangements between and among governmental agencies
- Protocols for information exchange

Implementation of the PSMA to Combat IUU Fishing

(1) Policy
- Setting PSMA as a Minimum Standard
- Integration and development of relevant policies, plans or strategies

(2) Legal
- Conformity and strong linkages between national laws, regulations and practices, and the PSMA

(3) Institutional
- Capacity and cooperation
- Cost-Benefit analysis
- No clear mandate
- Insufficient capacity
- Poor inter-agency cooperation
- Poor information, communication mechanisms
- Financial needs

Global, Regional and National Initiatives in Support of the Implementation of the PSMA

The entry into force of the 2009 FAO Port State Measures Agreement to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (PSMA) on 5 June 2016 has activated a set of duties and responsibilities for

States, Parties and other relevant entities. Nonetheless, some constraints had been identified at the global level that include: (i) shortcomings in national policies, laws and by-laws; (ii) inadequate institutional and operational capacities, particularly with regards to Monitoring, Control and Surveillance (MCS); and (iii) insufficient cooperation and coordination nationally, among States as well as at the regional level. In an effort to address such constraints, FAO formulated the global capacity development program "Support to the Implementation of the FAO Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing and Complementary Instruments" (FAO, 2016a).

The program aims to contribute to prevent, deter and eliminate illegal, unreported and unregulated (IUU) fishing and to improve the sustainability of fisheries. Its development outcome is the cohesive implementation at national and regional levels of the provisions of the PSMA as well as complementary international instruments and regional mechanisms to combat IUU fishing.

Efforts of FAO in promoting the implementation of the PSMA in Southeast Asia

FAO provided several technical support and assistance to implement the PSMA, such as the conduct of technical meetings and consultations as well as capacity development. At the request of the FAO Committee on Fisheries (COFI) in 2011, an informal open-ended technical meeting was organized by FAO in November 2011 to review the draft terms of reference (TORs) referred to in paragraph 6 of Article 21 of the Agreement, concerning the requirements of developing States. FAO also initiated a global series of regional workshops to provide essential information about the PSMA focusing on the role, responsibilities and obligations of port States; raise awareness about the benefits of implementing the PSMA; facilitate knowledge building and skills development for managers and inspectors in relation to the PSMA; review stakeholders' perspectives on port State measures and good governance issues; strengthen and harmonize port State measures at regional level; highlight the importance of developing concerted actions between port States and flag States in implementing port State measures effectively; encourage the enforcement of the implementation of existing Regional Plans of Action to combat IUU fishing and development of new ones; facilitate exchange of national experiences in combating IUU fishing through participation in activities dealing with real world situations; highlight the role of regional fisheries management organizations and arrangements (RFMOs) in the implementation of the PSMA; draw up related national and regional action plans and recommendations in general, legal and policy, institutional and capacity development and operational terms; and identify the opportunities for regional cooperation to implement port State measures. During the series of meetings, consultations and training, FAO came up with recommendations (FAO, 2012) for the Southeast Asian region to consider during the implementation of port State measures to combat IUU fishing (**Box 2**).

Moreover, FAO's Technical Cooperation Program and Projects for Assistance and Capacity Building provided technical assistance to some developing countries such as Ghana, Thailand, St. Kitts and Nevis, Bahamas, among others, in relevant aspects, namely: Legislative Review and Drafting; National Plan of Action on IUU Fishing; Action Plan to Address EU IUU Fishing Concerns; Training on Monitoring, Compliance and Surveillance; Boarding and Port Inspection Training; Law Enforcement Training; Training of Magistrates and other judicial officers; and Inter-agency Cooperation.

Initiatives of SEAFDEC in promoting countermeasures to combat IUU fishing in Southeast Asia

The Southeast Asian Fisheries Development Center (SEAFDEC) has also developed measures and tools to combat IUU fishing in the waters of Southeast Asia (Ishii *et al*., 2017). Based on such initiatives and with technical assistance from SEAFDEC, the ASEAN Member States

Box 2. Recommendations of FAO for the Southeast Asian region to implement port State measures to combat IUU fishing (FAO, 2012)

General Aspects

Southeast Asian Fisheries Bodies should:

- Conduct regional workshops to promote the benefits of port State measures (PSM)
- Set up a regional network to improve bilateral and multilateral cooperation particularly in information-sharing

(***Note:*** support of existing Regional Fisheries Bodies and Arrangements to establish the network is desired)

Legal and Policy Aspects

Southeast Asian Fisheries Bodies should:

- Conduct regional training programs on the legal interpretation of Port State Measures Agreement (PSMA) for legal experts and high ranking officials
- Develop an advisory document on preliminary actions that support PSM within existing legislations
- Promote sub-regional arrangements for cooperation on PSM and combating IUU fishing
- Seek to harmonize policy and legislation bilaterally and at regional level (possibly through the ASEAN mechanism)
- Seek to include RFMOs in regional policy and IUU fishing related activities
- In preparation for implementation of **PSMA Article 6**, develop a regional MOU between competent fishery organizations for sharing and updating of information on PSM through:
  - Establishment of a regional database of national PSM regulations
  - Development of consolidated information on national procedures for access to ports
  - With support from IOTC, harmonization on PSM among its members

Institutional and Capacity Development (establishment of MOUs)

Southeast Asian Fisheries Bodies should, *as part of the recommendation to establish MOU:*

- Convene regional coordination meetings among relevant Regional Fisheries Bodies (RFBs) to develop an agreement on the establishment of a regional database and information system, including a record of authorized vessels, IUU vessel lists, list of designated ports and port inspection results
- Strengthen the cooperation among existing RFBs, by drawing up formal agreements and other mechanisms, such as coordination meetings, with possible assistance of FAO

Institutional and Capacity Development (regional harmonization of activities)

Southeast Asian Fisheries Bodies should, *as part of the regional harmonization of activities:*

- Convene a regional working group from representatives of each country to establish the Regional Standards of Practices (SOPs) for Port Inspections
- Strengthen the implementation of the RPOA-IUU, including securing additional technical and financial resources

(***Note:*** In this regard, the RPOA-IUU Secretariat and participating countries are encouraged to secure sufficient funding

Institutional and Capacity Development (dissemination and sharing of information)

Southeast Asian Fisheries Bodies should, *subject to operations, under a regional MOU referred above:*

- Develop web-based information and tool kits for inspectors
- Establish a scheme for joint and reciprocal inspections

(AMSs) have also initiated actions to address their respective countries' concerns in combating IUU fishing in their waters through the establishment of relevant measures and management tools.

Specifically, in the implementation by SEAFDEC of the JTF-funded project "Promotion of Countermeasures to Reduce IUU Fishing," the AMSs collaborated with SEAFDEC to establish various management tools and measures, which are meant not only to combat IUU fishing but also to enhance the competitiveness of the ASEAN fish and fishery products (Ishii *et al*., 2017). 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; and (6) Regional Guidelines on Traceability System for ASEAN Aquaculture Products.

The status of the implementation of such instruments by the AMSs is shown in **Box 3**. As for the promotion of PSM in the region, this has been mainly constrained by the unavailability of experts capable of studying the relevant legal frameworks of the AMSs *vis-à-vis* the implementation of the PSMA. Nevertheless, SEAFDEC continued to organize meetings, workshops and capacity

Box 3. Management tools and measures to combat IUU fishing and enhance the competitiveness of ASEAN fish and fishery products developed by the AMSs with assistance from SEAFDEC (Ishii *et al*., 2017)

ASEAN Guidelines for Preventing the Entry of Fish and Fishery Products from IUU Fishing Activities into the Supply Chain
- Spearheaded by SEAFDEC Marine Fishery Resources Development and Management Department (MFRDMD)
- 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
- MFRDMD assists the AMSs in addressing the issues and concerns that impede the adoption of the Guidelines in their respective countries

Regional Fishing Vessels Record Database for Vessels 24 Meters in Length and Over
- Coordinated by SEAFDEC Training Department (TD)
- Initially focusing on large fishing vessels with length from 24 meters and over, the Regional Fishing Vessels Record (RFVR) would be used as a management tool for combating IUU fishing in the region
- RFVR Database, an online system containing RFVR information, managed by TD
- 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

Regional Plan of Action for Management of Fishing Capacity
- Regional Plan of Action for the Management of Fishing Capacity (RPOA-Capacity) was developed by SEAFDEC as guide for the management of fishing capacity in an ASEAN perspective
- Meant to support the AMSs in the development and implementation of their respective National Plans of Action for the Management of Fishing Capacity
- RPOA-Capacity to be used as guide for AMSs to establish management measures for shared stocks (*e.g.* longtail tuna and kawakawa in the Gulf of Thailand and Andaman Sea)
- Based on results of evaluation of the extent of implementation of the RPOA-Capacity by the AMSs, gap analysis will be carried out by SEAFDEC

Regional Cooperation to Support the Implementation of Port State Measures in the ASEAN Region
- Coordinated by TD
- Regional cooperation being established to support the implementation of port State measures, and prevent the entry of illegally-caught fish into the international markets through the countries' ports
- Regional approaches developed to support the implementation of PSM by the AMSs
- Lack of expertise at SEAFDEC on PSMA, to enhance the promotion of the implementation of PSMA in the region
- FAO working closely with SEAFDEC in support of the implementation of PSMA by the AMSs

ASEAN Catch Documentation Scheme for Marine Capture Fisheries
- Developed and promoted by SEAFDEC in the region to secure the niche of the ASEAN fish and fishery products in the global market
- Meant to serve as a unified framework in enhancing traceability for effective marine fisheries management
- ASEAN Catch Documentation Scheme (ACDS) is voluntary for all the AMSs
- Implementation of the electronic format of the ACDS (e-ACDS) currently being pilot-tested in the AMSs

Regional Guidelines on Traceability System for ASEAN Aquaculture Products
- Coordinated by SEAFDEC Marine Fisheries Research Department (MFRD) in cooperation with SEAFDEC Aquaculture Department (AQD)
- Aimed at securing the niche of ASEAN fish and fishery products from aquaculture in the global market
- 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 Guide for AMSs in formulating national programs and activities that aim to promote traceability of aquaculture products


building activities not only to raise the awareness of stakeholders from the region on the PSM concepts but also to enhance their understanding of the requirements contained in the PSMA (Saraphaivanich, *et al*., 2017).

National initiatives in promoting the implementation of PSM in Southeast Asia

The study "National Coordination and Implementation of Port State Measures in Selected States in the Southeast Asian Region" by Onoora (2008) which focused on selected States, namely: Indonesia, Philippines, and Thailand, aimed to identify and assess the legal requirements and institutional mechanisms necessary for the implementation of the PSM. Results of the study had indicated some differences regarding the countries' specific laws and regulations in dealing with measures to combat IUU fishing, particularly with respect to port State measures.

However, there were some common concerns at the national level and challenging issues relating to combating IUU fishing activities in the Southeast Asian region. These include insufficient coordination and collaboration among different agencies concerned, inadequate laws and regulations to directly deal with the IUU fishing problems, inadequate qualified staff, insufficiency in information, and need to establish MCS network in the region and acquisition of appropriate equipment necessary to combat IUU fishing especially through port State measures at the present stage.

Experience of Thailand before acceding to the PSMA

On the part of Thailand, it had undertaken several actions to prevent, deter and eliminate illegal, unreported and unregulated fishing through the implementation of port State measures, while subjecting itself to the preparatory processes and actions before becoming a Party of the PSMA. Such actions were accomplished through the attendance of relevant officers and staff in various international and regional workshops and training programs organized by either FAO or SEAFDEC or the Indian Ocean Tuna Commission (IOTC) since 2008, as a member country of these organizations. The Department of Fisheries of the Ministry of Agriculture and Cooperatives of Thailand assigned relevant officer/staff to study the major concepts in many international instruments, such as the **Code of Conduct for Responsible Fisheries (CCRF), International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (IPOA-IUU)**, and the **FAO Model Scheme on Port State Measures to Combat IUU Fishing**, initiated by FAO and implemented among the FAO member States.

The research paper written by Onoora (2008) on "National Coordination and Implementation of Port State Measures in Selected States in the Southeast Asian Region" was used as working document during the FAO/APFIC/SEAFDEC Regional Workshop on Port State Measures to Combat Illegal, Unreported and Unregulated Fishing. During June 2008 to August 2009, a Delegation comprising DOF Officers participated in the "Technical Consultation to Draft a Legally-binding Instrument on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing" at the FAO Head Office in Rome, Italy (Onoora, 2008). After 4 rounds of technical consultations, the 2009 FAO Port State Measures Agreement (PSMA) was drafted as the first and significant legal-binding instrument under the State jurisdiction at ports.

The PSMA was translated into the Thai national language in 2013 with support from FAO and SEAFDEC to provide greater access and clear understanding on the PSMA by the Thai officials and fishers throughout the country. During the preparations for accession, Thailand revised the Structural Chain of Command of the Department of Fisheries (**Box 4**) to facilitate the implementation of the PSMA in the country.

The common needs were also identified, such as capacity building, information sharing, review and redrafting of specific laws or regulations dealing with the application of port State measures, and establishment of regional MCS network in the Southeast Asian region. Nevertheless, to achieve the common goal of using the PSMA as tool to


Box 4. Revisions of the Structural Chain of Command of the Department of Fisheries of Thailand

Setting up of new Division: Fish Quarantine and Inspection Division to include: • Port State Measures Implementation Group • Fish Quarantine and Inspection Regional Center 2 (Bangkok) • Fish Quarantine and Inspection Regional Center 3 (Songkhla)
Setting up of 22 new PSM ports for port entry of foreign vessel, divided into 16 international ports and 6 neighboring ports
Employed PSM staff in each designated port, approximately 30-50 staff per port, and provided them special training on PSM-related works
Establishment of international networking with both flag States and coastal States within the Southeast Asian region and beyond, for cross-checking traceability system and inspection of fish products from foreign fishing vessels that request access to a fishing port of Thailand
Setting up of a specific committee prior to accession to the PSMA by Thailand, to urgently consider the advantages and disadvantages if Thailand intends to ratify the PSMA, and the Parliament endorsed the intentions of Thailand to become a Party in the PSMA

Box 5. Clarification on the terms "illegal," "unreported," and "unregulated" as they relate to fishing activity (FAO, 2002)

Illegal fishing refers to fishing activities --- (1) Conducted by national or foreign vessels in waters under the jurisdiction of a State, without the permission of that State, or in contravention of its laws and regulations; (2) Conducted by vessels flying the flag of States that are parties to a relevant regional fisheries management organization but operate in contravention of the conservation and management measures adopted by that organization and by which the States are bound, or relevant provisions of the applicable international law; or (3) In violation of national laws or international obligations, including those undertaken by cooperating States to a relevant regional fisheries management organizations.
Unreported fishing refers to fishing activities --- (1) Which have not been reported, or have been misreported, to the relevant national authority, in contravention of national laws and regulations; or (2) Undertaken in the area of competence of a relevant regional fisheries management organization which have not been reported or have been misreported, in contravention of the reporting procedures of that organization.
Unregulated fishing refers to fishing activities --- (1) In the area of application of a relevant regional fisheries management organization that are conducted by vessels without nationality, or by those flying the flag of a State not party to that organization, or by a fishing entity, in a manner that is not consistent with or contravenes the conservation and management measures of that organization; or (2) In area or for fish stocks in relation to which there are no applicable conservation or management measures and where such fishing activities are conducted in a manner inconsistent with State responsibilities for the conservation of living marine resources under international law.

combat IUU fishing in the region, more time, cooperation, participation, and support of relevant parties such as policy-makers and all stakeholders from the government and private sectors are desperately needed.

Implementation of Port State Measures in Southeast Asia: a simulation exercise

There had been unclear interpretations regarding some terminologies, such as "illegal fishing" and "illegal, unreported and unregulated fishing" or so-called "IUU fishing." From the legal point of view in applying these terms, the legal consideration is to focus on whether a law or a regulation is available and in place. If the answer is Yes and the actions done by fishers violate specific laws or regulations, then the violated actions are consider to be "illegal fishing." On the other hand, the meaning of "IUU fishing" as officially defined by the FAO Technical Guidelines for Responsible Fisheries #9 is shown in **Box 5** (FAO, 2002).

A Simulation Exercise to Implement Port State Measures

This simulation exercise is presented as an example only although it is based on the actual action with focus on some legal perspectives and implications. This simulation case involves **State A** acting as the coastal State, **State B** as flag State, **State C** as port State, and **Fishing Vessel FV.1**, as the main actors.

State A has requested **State C** to control and confiscate **FV.1** at port of **State C** claiming that **FV.1** has been involved in IUU Fishing activities in the waters of State A by sending official letter to the government office of **State C** and requesting for legal assistance. In fact, **State A** is Party of the PSMA but **State C** is not, so **State C** does not have any obligation to comply with the provisions of the PSMA. Even if **State C** has not yet been a Party of the PSMA, it can implement PSM if it wishes to do so, although not the PSMA. Thus, **State C** cooperated with **State A** by contacting **State B**, a Party of PSMA, to verify about the nationality of **FV.1** and inquire whether **FV.1** has the nationality of **State B** and allowed to fly the national flag of **State B**. From the communications and good cooperation with **State B**, it was found that **FV.1** has never been registered with **State B**, so **FV.1** does not have **State B** nationality. In this case, **FV.1** is considered as a "stateless vessel." As a port State, **State C** has the full sovereignty to implement all national laws and regulations over its port such as laws relating to customs, safety of vessels, sanitation, and fisheries laws. Nonetheless, **FV.1** should be allowed to prove its innocence for not having been involved in IUU fishing activities in the waters of **State A**, *e.g.* documentary proof that the fish products onboard **FV.1** have been legally caught with authorized licenses issued by the authorities of **State A**. At the same

time, the role of **State C** is to cooperate with **State A** in combating IUU fishing in this region even though it has not yet accessioned to be a Party of the PSMA, and for **State A** through enforcement of relevant national legislations, to inspect the fish products onboard the **FV.1**.

As a result, since it was found that **FV.1** has no license to carry and land the fishery products, so **State C** arrested the **FV.1** and confiscated all fish products onboard. Moreover, it was found that **FV.1** did not have enough safety equipment on board, so the marine authorities of **State C** ordered the Captain of the **FV.1** to install the proper equipment and tools needed onboard. After the legal enforcements above, the authorities of **State C** officially reported the results of inspection and all operational treatments accorded the **FV.1** to **State A** as a coastal State, **State B** as relevant State, and the Regional Fisheries Management Organization (RFMO) where **State C** is a member, for them to know about all the actions that had been done on the **FV.1**.

In conclusion, the legal analysis and implications that could be derived from this sample case, depend on: the status of the involved States (flag, coastal, port or market State); legal status to PSMA of relevant States; being a Party or Non-Party; Port State Measures to combat IUU fishing; provisions of PSMA to be complied with by States concerned; diplomatic relationship among all the States concerned; international and regional cooperation and coordination among States concerned; and involvement of RFMOs in the region. This simulation exercise would be useful for Southeast Asian countries in providing practical guidelines for future actions.

Constraints and Issues in the Implementation of Port State Measures

There are many constraints and challenges to the implementation of the PSMA, particularly for developing countries. However, it is implicit in Article 21(4) of the PSMA for Parties to cooperate in establishing funding mechanisms to assist developing States in the implementation of the PSMA.

The mechanisms are to be directed specifically towards: (i) developing national and international port State measures; (ii) developing and enhancing capacity on MCS and training of port managers, inspectors, enforcement and legal personnel at the national and regional levels; and (iii) implementing MCS and compliance activities relevant to port State measures and accessing technologies and equipment (Doulman and Swan, 2012).

One of the outcomes of the global series of FAO Regional Workshops to improve human and technical capacity for countries to strengthen and coordinate their port State measures, is identification of the clear steps that national fisheries administrations could take to develop port State measures. In this context, the working groups, in each of the abovementioned Workshops, identified the constraints to the development of port State measures and proposed the ways to overcome such concerns. The constraints identified were generally consistent throughout the various regions, and related mainly to institutional arrangements, technical requirements, legal considerations, financial needs, human resource development, and regional and international concerns.

Subject to legal considerations, the constraints regarding the implementation of the PSMA range from the national to regional levels. At the regional level, many countries are concerned with ensuring full and effective legal implementation of measures and decisions of RFMOs in which they participate. These situations may result in the failure of national laws to legally implement international and regional instruments and obligations. An associated problem is when the national law could not be made consistent with the requirements in the PSMA and

Box 6. Challenges arising from developing countries related to implementation of PSMA

- Insufficient integration of legislative requirements into national policies as cited during the FAO regional workshops that constrain all efforts to prioritize legal implementation
- Weak or inadequate legal frameworks
- Outdated fisheries and related laws, exist to a great extent in developing countries
- Need for legal assistance from donor countries or organizations to review and update legislations
- Increased political will in adopting new legislations
- Inadequacy of penalty levels and inconsistency of such levels throughout a region
- Need to address penalty levels at regional level to promote their impact, consistency and effectiveness
- Limited number of bilateral and/or multilateral arrangements between coastal States in many regions
- Lack of harmonized legislation or inconsistency of legislation in the region
- Harmonization of the implementation of the PSMA as a minimum standard

Box 7. Common constraints encountered by Southeast Asian countries that impede the implementation of PSMA

Legal problems

- Subject to implementation of laws and regulations (insufficient legal provisions), the **challenges** of Brunei Darussalam, Cambodia, Indonesia, Malaysia, Singapore, Thailand, and Viet Nam include: inconsistent law interpretations, need to amend and update existing regulations, and need to review and update relevant fisheries acts
- Regarding the interpretation of PSMA, the **challenges** of Brunei Darussalam, Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam include: interpretation of PSMA by non-fisheries stakeholders not comprehensive, need to establish MOU among concerned government agencies, need assistance from legal officers of FAO for the correct interpretation of the provisions of PSMA for law enforcement officers and managers, and need assistance to ensure correct translation of PSMA into the local languages of concerned countries

Operational problems

- Issues relating to standard operating procedures (SOPs) in implementing PSM with any scale of foreign vessel (*i.e.* lack of, incompleteness of, outdated), the **challenges** of Brunei Darussalam, Cambodia, Indonesia, Myanmar, Philippines, Singapore, and Viet Nam include: need to renew and recognize fishing port operational procedures to support PSM, development and updating of harmonized SOPs on vessel inspection at port for more comprehensive and guidance of all AMSs, identification of the needs and capacity building for staff concerned on relevant aspects of PSM implementation
- For ports managed by different agencies, insufficient inter-agency cooperation for PSM implementation, the **challenges** of Brunei Darussalam, Cambodia, Indonesia, Myanmar, Philippines, and Viet Nam include: sharing of information on vessel entry permit among concerned agencies such as fisheries departments, harbor departments, customs, and others; and need to establish ASEAN Fish Market Federation to promote and implement the ASEAN Catch Documentation Scheme (ACDS)

Human resource problems

- Brunei Darussalam, Cambodia, Indonesia, Myanmar, Philippines, Thailand, and Viet Nam have common constraints on limited capacity of implementing facilities and officers concerned, and need to develop capabilities across all levels, *e.g.* policy makers, port managers, inspectors, and the like, and technical support on how to operate communication equipment as their priority requirements

Infrastructure problems

- Brunei Darussalam, Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam have common constraints related to insufficient infrastructures for PSM, such as infrastructure for port and for information systems, thus assistance is needed to help in setting up or upgrading electronic databases and systems, *e.g.* electronic catch document scheme, database for catch records, VMS, MCS, GPS/AIS/other communication systems; and understanding the requirements and criteria of appropriate designated ports
- Brunei Darussalam, Cambodia, Indonesia, Malaysia, Myanmar, Philippines, and Viet Nam have common constraints on the insufficiency of budget for infrastructure to support PSM, *i.e.* infrastructure for port and for information systems, thus FAO had been requested to help finance the development and implementation of their port management systems; and budget allocation for setting up and upgrading electronic databases and systems, *e.g.* electronic catch documentation scheme, database to record catch records, VMS and MCS and other communication systems

Information-related problems

- Brunei Darussalam, Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam have common constraints on non-updated IUU fishing vessels list from RFMOs, thus proposing to FAO to publish a consolidated list of IUU fishing vessels on its website, so that there is no need for countries to check various RFMOs' or international organizations' websites
- Brunei Darussalam, Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam have common constraints on lack of awareness among the stakeholders and concerned agencies about PSM, thus capacity building and awareness raising activities are necessary, which should target the government agencies and relevant stakeholders
- Cambodia, Indonesia, and Philippines have common constraints on lack of information sharing between agencies where control of ports fall under different port authorities, thus requesting the assistance from FAO to help in proposing the revision of the roles and responsibilities of various agencies related to the implementation of PSM

associated instruments. In addressing these challenges, it would be important to consider the legal checklist against national legislations (**Box 6**), identify the gaps and inconsistencies, and propose appropriate revisions.

Moreover, the constraints encountered by Southeast Asian countries were also identified as shown in **Box 7** (FAO, 2016b), where addressing such constraints are the top priority activities of the concerned countries. Meanwhile, the possible constraints in the implementation of the PSMA at the national level, especially when a State becomes a Party to the PSMA, are summarized in **Box 8**.

Box 8. Possible constraints in the implementation of PSMA at national level

At the national level, the Checklist Document suggests that some initial considerations for the implementation of the PSMA when a State becomes a Party to it. These considerations could include the need to:

- Review and compile national legislations and procedures related to the implementation of PSM, as well as the duties and responsibilities of the flag, coastal and market States
- Identify and collect information related to integration and coordination mechanisms at the national, sub-regional, regional and international levels, while it is important to review if the legislations ensure the integration and coordination of fisheries related port State measures with the broader system of port State controls, including for example, vessel monitoring system (VMS) and observers' programs
- On the role of a Party as a flag State, the PSMA gives some discretion to each Party to decide on the application of the PSMA, but should in general promote better compliance of conservation and management measures
- Identify the requirements for assistance, training and cooperation when a State becomes a Party to the PSMA

Benefits of ratifying and implementing the PSMA

The PSMA was adopted by the FAO Conference in 2009 for the main purpose of preventing, deterring and eliminating IUU fishing through the implementation of port State measures (FAO, 2009). The Parties, in their capacities as port States should apply the PSMA in an effective manner, to foreign vessels seeking entry to ports or while still at ports. The application of the measures set out in the PSMA would, *inter alia*, contribute to harmonized port State measures, enhance regional and international cooperation, and block the flow of IUU-caught fish and fishery products into national and international markets.

As a legally-binding instrument, the PSMA stipulates minimum standards of port States measures, although the States are free to adopt more stringent measures than those outlined in the PSMA. In order to obtain the full effect of the implementation PSMA at the national level, the requirements stipulated in the PSMA should be incorporated into national legislations. Even before the PSMA was entered into force, many States including those that do not wish to become Parties had been implementing PSM which are now set out in the PSMA. Nonetheless, FAO continues to encourage the countries to include PSM in their national legislations, and to actively promote the implementation of PSM as tool in combating IUU fishing.

There are positive effects of ratifying and acceding to the PSMA, to the countries and the region, considering that IUU fishing is a major problem in capture fisheries and poses a serious threat to the effective conservation and management of many fish stocks. IUU fishing can at its worst lead to the total collapse of a fishery or at least seriously impair the condition of fish stocks including efforts to rebuild stocks that have been overfished, situations that are likely to lead to loss of economic revenues both directly through fish sales and indirectly through social opportunities such as employment. Enhanced implementation of PSM has an important role in combating IUU fishing because it complements the efforts of flag States in fulfilling their responsibilities under international laws. The PSMA provides the legal right to port States in inspecting and verifying vessels that are not flying their flags but wishing to seek permission to access their ports or are already in their ports. The inspections are meant to make sure that vessels entering into ports have not been engaged in IUU fishing activities.

Moreover, the PSMA provides the rights for flag States to have control over vessels as the PSMA requires the flag States to take certain actions, at the request of the port States or when vessels flying their flags are suspected to have been involved in IUU fishing activities. This responsibility ensures that flag States continue to exercise control over vessels flying their flags in areas beyond their national jurisdictions. The PSMA also requires better and more effective cooperation and information exchange among coastal States, flag States and regional fisheries management organizations and arrangements (RFMOs/RFMAs).

The PSMA also seeks to prevent the occurrence of so-called ports of non-compliance (formerly known as ports of convenience), since countries operating ports of non-compliance do not regulate effectively the fishing operations and related activities that take place in their waters, and do not determine whether IUU-caught fish are landed, transshipped, processed, and sold in their ports. Ratifying of or acceding to the PSMA and robustly implementing its measures will reduce the number of

Tuna transshipment and unloading

ports of non-compliance and the opportunities for vessels to dispose of IUU-caught fish with relative case.

Moreover, the State being a Party to and implements the PSMA, could promote strengthened fisheries management and governance at all levels. PSM are cost-effective tool in ensuring compliance with national laws as well as regional conservation and management measures adopted by RFMOs. This is because port States do not have to expend time, effort and resources in monitoring, pursuing and inspecting vessels at sea. Port inspections and controls are very much cheaper and safer than the alternative and more conventional air and surface compliance tools.

Box 9. Framework of proposed Model for implementing PSM in Southeast Asia

The key issues for future actions and regional cooperation in effectively implementing port State measures to combat IUU fishing in the Southeast Asian Region include:

1. Strong political will and regional support
2. Harmonization and standardization of policies
3. Development of legal frameworks
4. Promotion of regional and sub-regional MCS networks
5. Capacity building and/or needs assessment
6. Information sharing and activity coordination

Issue 1: Ensuring political will and regional support by:

- Involving the FAO Asia-Pacific Fisheries Commission (APFIC), ASEAN and SEAFDEC in the process of implementing PSM
- Raising public awareness through communication strategies and campaigns

Issue 2: Harmonization and standardization of policies through:

- Development of regional minimum standards for port State measures
- Agreement on appropriate mechanisms, *e.g.* under APFIC, SEAFDEC, ASEAN, and/or the RPOA IUU
- Elaboration of standard operating procedures
- Designation of ports where port State measures will be implemented

Issue 3: Development of legal frameworks through:

- Cooperation at regional level to develop legal instruments to implement port State measures, based on relevant international instruments
- Establishment of regional legal working groups to address the implementation, strengthening and harmonization of port State measures
- Identification of key legal constraints and needs for the Southeast Asian region
- Establishment of a framework of cooperation and network among countries for sharing of information and knowledge, lessons learned, successful cases, and relevant practices
- Review and/or revision and updating of national legislations to effectively implement port State measures
- Development of bilateral and/or regional mechanisms to implement port State measures in the region
- Availing of expertise from international and regional organizations, to assist in setting up the legal frameworks for implementing port State measures

Issue 4: Promotion of regional and sub-regional MCS networks by:

- Engaging other initiatives in dealing with topics related to oceans and coastal environment, where IUU fishing is also an issue
- Sharing of MCS tools

Issue 5: Capacity building and/or needs assessment through:

- Port inspection and boarding procedures, and transmittal of inspection reports
- Orientation on systematic cooperation and sharing of information
- Treatment of presumed fishing vessels to have engaged in IUU fishing
- Establishment of techniques on how to detect IUU fishing fraudulent documents, mis-declaration of catch, vessel renaming and reflagging

Issue 6: Information sharing and activity coordination through:

- Inter- and intra-government collaboration
- Timely coordination between and among SEAFDEC Member port States
- Cooperation among national authorities
- Promotion of inter-agency cooperation within governments
- Coordination with industry, mindful that this will involve the implementation of port State measures and possible traceability schemes

When used in conjunction with catch documentation schemes (CDS), PSM have the potential to be one of the most cost-effective and efficient means of combating IUU fishing, since implementing it through national legislations will provide incentives to establish coordinated procedures and facilitate intra-agency cooperation. As a compliance and enforcement tool, PSM have positive effect on fisheries conservation and management by contributing to more accurate and comprehensive data collection, enhancing vessel reporting to national administrations and RFMOs, permitting assessments on the extent to which vessels have complied with operational authorizations and licenses to fish, and promoting regional fisheries

Box 10. Possible Model for PSMA Implementation by a PSMA Party

Among the Southeast Asian countries, only Indonesia, Myanmar and Thailand are at present, Parties to the PSMA, while some countries are undergoing the necessary domestic processes to access/ratify/accept the PSMA in the future. Thus, the proposed possible model for Party involves analyzing the obligations set forth in the PSMA and capabilities of Parties to PSMA in the region.

Duties of Party to PSMA

a. Policy – to implement PSMA as a minimum standard of country
- Enact specific national laws and regulations to support the implementation of port State measures in own county
- Make legal adjustments at the national level for the implementation of the PSMA
- Integrate and develop relevant policies, plans or strategies
- Provide a strong support to the implementation of actions by prioritizing them on the national and sectorial agenda
- Cooperate and exchange information with relevant RFMOs, including measures adopted by RFMOs in relation to the objective of the PSMA (Swan, 2016)
- Move forward in a coherent manner

b. Legal – conformity and strong linkages between national laws, regulation and practices and the provision of PSMA
- Review and collect the national legislation and procedures in relation with the implementation of the PSM, as well as flag, coastal and market state responsibilities and duties
- Designate legal power to Denial the Use of port AFTER ENTRY in national legislation
- Ensure that there are specific provisions in the national legislation to support in implementation of PSMA especially for providing legal authority for officials and inspector
- Amend relevant penalties in national legislation for violating the provisions of port State measures

c. Institutional - strengthen capacity and cooperation
- Encourage to do cost-benefit analysis
- Identify clear mandate
- Strengthen capacity
- Promote inter-agency cooperation
- Develop information, communication mechanisms
- Seek for financial support from regional donors

d. Capacity Building – identify needs for assistance, training and cooperation that are useful when a State becomes a Party to the PSMA

cooperation and harmonization among coastal States and RFMO members.

Through regional cooperation, the port States and other States that are RFMO members are assured of the benefits from the information obtained through the implementation of PSM. Consequently, the PSMA facilitates and strengthens regional cooperation, including harmonization through RFMOs role in implementing the PSMA, of provisions that focus on denial of access to ports, port inspections, prohibition of landings, and detention and sanction that can prevent the fish caught through IUU fishing activities from reaching the national and international markets. By making it more difficult to market fish through the application of PSM, the economic incentive to engage in IUU fishing is reduced.

It should be noted that many countries have also decided to prohibit trading with countries that do not have PSM in place. The adoption of PSMA that seeks to enhance

Box 11. Possible Model for PSMA implementation by non-Party to the PSMA

Legal Framework: Non-Party country should:
- Consider implementing PSM although without any legal obligation to comply with the provisions of PSMA
- Provide essential information about the PSMA focusing on the role, responsibilities and obligations of the port States
- Raise awareness among nationals about the benefits of implementing the PSMA
- Promote ways to strengthen coordination and collaboration among various agencies concerned at national, regional and global levels
- Review stakeholders' perspectives on port State measures and good governance issues
- Participate in related national and regional action plans and recommendations in general, legal and policy, institutional and capacity development and operations terms
- Review and redraft specific laws or regulations dealing with the application of port State measures

Legal Framework: Regional Fisheries Management Bodies/Arrangements should:
- Highlight the importance of developing concerted actions between port States and flag States in implementing port State measures effectively
- Establish a regional MCS network in the Southeast Asian region
- Encourage the enforcement of the existing Regional Plans of Action to combat IUU fishing and development of new ones
- Facilitate exchange of national experiences in combating IUU fishing through participation in activities dealing with real world situations
- Identify opportunities for regional cooperation to implement PSM
- Conduct regional workshop to promote the benefits of PSM
- Set up a regional network to improve bilateral and multilateral cooperation particularly in information-sharing, and establish the network as desired

Legal and Policy Aspects: Regional Fisheries Management Bodies/Arrangements should:
- Conduct regional training programs on the legal interpretation of PSMA for legal experts, high ranking officials and relevant authorities
- Promote sub-regional arrangements for cooperation on PSM and combating IUU fishing
- Seek to harmonize policies and legislations bilaterally and at regional level (possibly through the ASEAN mechanism)
- Establish a regional database on national PSM regulations
- IOTC, to support harmonization of PSM among its members
- Convene regional coordination meetings among relevant Regional Fisheries Bodies (RFBs) to seek agreement on the establishment of regional database and information system, including a record of authorized vessels, IUU vessel lists, list of designated ports, and port inspection results
- Establish MOU among countries in the region for cooperation in data sharing, transfer of technology and other related actions as part of the regional harmonization activities
- Strengthen the implementation of the RPOA-IUU, including securing additional technical and financial resources as part of the regional harmonization activities
- Convene a regional working group from the representatives of each country to establish regional Standards of Practices (SOPs) for port inspections
- Promote the establishment of regional MOU between competent fishery organizations to share and update information on PSM, in preparation for implementing Article 6 of the PSMA

Legal and Policy Aspects: Non-Party country should:
- Promote the ways of strengthening coordination and collaboration among various agencies concerned at national, regional and global levels
- Develop an advisory document on preliminary actions that support PSM within existing legislations
- Establish MCS network in the region and appropriate tools to combat IUU fishing especially through PSM
- Provide assistance in setting up or upgrading electronic databases and systems, *e.g.* electronic catch document scheme
- Initiate more training sessions for trainers, as many as possible throughout the country to generate more qualified staff who understand the PSM, and conservation and management measures
- Promote establishment of regional MOU between competent fishery organizations to share and update information on PSM, in preparation for implementing Article 6 of the PSMA
- Develop consolidated information on national procedures for access to ports
- Share experiences and expertise with neighboring countries to address common difficulties

fisheries conservation and management, combat IUU fishing and reduce the volume of IUU-caught product entering national and international markets, reduces the incomes from IUU fishing activities, thus, the incentive to engage in such fishing would be reduced. Used in combination with other tools, PSM is therefore able to reduce the level of IUU fishing globally.

Conclusion and Recommendations

Based on the situation of the Southeast Asian countries, there are variety of means and ways to combat IUU fishing by implementing either the port State measures (PSM) or the 2009 FAO Port State Measures Agreement (PSMA), depending on the legal systems, policies on fisheries management, development of port inspection systems, and cooperation among several agencies and officials concerned with solving problems that arise from IUU fishing. However, the political will of the authorities of each country is very significant as this would lead the nations towards addressing such problems. To achieve the common goals as well as the common areas of interest such as capacity building and information sharing, strengthened cooperation, participation and support of the relevant parties such as policy-makers, stakeholders both from the government sector and private sector, are necessary.

Due to the variety of important factors that could affect the implementation of PSM in the Southeast Asian region, a Model to implement port State measures in this region (**Box 9**) is being proposed to be developed and implemented in real situations. This proposed Model could serve as the first step of the countries concerned to develop and establish some essential actions to cooperate and coordinate with global fisheries organizations, bodies and arrangements in the implementation of PSMA for combating IUU fishing activities in the Southeast Asian waters. The Model could also serve as a step towards enhancing closer cooperation and coordination in the implementation of PSM among the Southeast Asian countries in the near future, whether the countries are Parties (**Box 10**) or non-Parties (**Box 11**) to the PSMA. Nevertheless, this Model is an open-ended instrument which could be used as reference in developing regional guidelines for the implementation of port State measures in Southeast Asia.

References

Doulman, David J. and Judith Swan. 2012. A Guide to the Background and Implementation of the 2009 FAO Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing. ***In***: FAO Fisheries and Aquaculture Circular No. 1074 – FIPI/1074. Food and Agriculture Organization of the United Nations, Rome; pp 87

FAO. 2002. FAO Technical Guidelines for Responsible Fisheries 9: Implementation of the International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing. Food and Agriculture Organization of the United Nations, Rome; 122 p

FAO. 2009. FAO Conference Resolution 12/2009 approving the 2009 FAO Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing.

FAO. 2012. FAO Fisheries and Aquaculture Report No. 1008. Report of the FAO/APFIC Workshop on Implementing the 2009 FAO Agreement on Port State Measures to Combat Illegal, Unreported and Unregulated Fishing, Bangkok, Thailand, 23-27 April 2012; 63 p

FAO. 2016b. Report of the Workshop on Regional Cooperation for Implementation of Port State Measures to Improve Fisheries Management and Reduce IUU Fishing in Southeast Asia, 7-10 November 2016, Bangkok, Thailand

FAO. 2016a. Report of the FAO Workshop on Implementing the Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing in the Mediterranean and Black Sea. Tirana, Albania, 29 February–4 March 2016. FAO Fisheries and Aquaculture Report. No.1151. Rome, Italy

Ishii, Kaoru, Tetsuya Kawashima, and Virgilia T. Sulit. 2017. Towards Sustainable Fisheries Development in Southeast Asia: the Twenty-Year Japanese Trust Fund Saga in SEAFDEC. ***In***: Fish for the People Volume 15 Number 3: 2017. Southeast Asian Fisheries Development Center, Bangkok, Thailand; pp 2-13

Kuemlangan, Blaise. 2008. FAO's initiatives to fight Illegal, Unreported and Unregulated Fishing. Paper presented during the FAO Regional Workshop on Port State Measures to Combat Illegal, Unreported and Unregulated Fishing, Cape Town, South Africa, 28-31 January 2008

Kuemlangan, Blaise. 2017. The Implementation of the Agreement. Paper presented during the FAO Workshop on Formulation of a National Strategy and Action Plan for Compliance with the 2009 FAO Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing, Bangkok, Thailand, 4-8 September 2017

Nathiesen, Arni. 2017. Opening Speech delivered during the First Meeting of the Parties to the Agreement on Port State Measures Oslo, Norway, 29-31 May 2017; pp 26

Onoora, Poungthong. 2008. National Coordination and Implementation of Port State Measures in Selected States in Southeast Asian Region. ***In***: FAO Fisheries and Aquaculture Report No. 868. Report of the FAO/AFPIC/SEAFDEC Regional Workshop on Port State Measures to Combat Illegal, Unreported and Unregulated Fishing, Bangkok, Thailand, 31 March-4 April 2008; pp 38-44

Saraphaivanich, Kongpathai, Yanida Suthipol, and Namfon Imsamrarn. 2017. Strengthening Regional Cooperation to Support the Implementation of Port State Measures in Southeast Asia. ***In***: Fish for the People Volume 15 Number 3: 2017. Southeast Asian Fisheries Development Center, Bangkok, Thailand; pp 17-22

SEAFDEC. 2017. Updating of Summary of Constraints/ Problems, Challenges and Priority Activities on PSM Implementation. ***In***: Report of the Workshop on Regional Cooperation for Implementation of Port State Measures to Improve Fisheries Management and Reduce IUU Fishing in Southeast Asia, Bangkok, Thailand, 7-10 November 2016, Southeast Asian Fisheries Development Center, Bangkok, Thailand; pp. 78-81

Swan, Judith. 2016. Implementation of Port State Measures: Legislative Template, Framework for Procedures, Role of Regional Fisheries Management Organizations. Food and Agriculture Organization, Rome; 169 p

Swan, Judith. 2017. FAO Port State Measures. Paper presented during the Tenth International Forum on Illegal, Unreported and Unregulated Fishing, 16-17 March 2017, Chatham House, London

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Application of GIS and Remote Sensing for Advancing Sustainable Fisheries Management in Southeast Asia

Worawit Wanchana and *Suwanee Sayan*

Through the adoption of the ASEAN-SEAFDEC Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2020 by the Senior Officials of the ASEAN-SEAFDEC Member Countries in June 2011, the countries recognized that various "*management approaches are required to sustainably manage the region's critical coastal habitats, such as mangroves, coral reefs, and sea grasses*," and that "*information on the appropriate measures and interventions should be disseminated to improve fisheries management*." At the same time, the countries also agreed that there is a need to "*enhance the resilience of fisheries communities to participate and adapt to the changes in environmental conditions of inland and coastal waters*" as indicated in the ASEAN-SEAFDEC Resolution on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2020 also adopted in June 2011. In this connection, this article therefore provides some insights on the application of geographical information system (GIS) and remote sensing (RS) technologies as means to advance the development and management of inland and marine capture fisheries in the Southeast Asian region.

The countries in the Southeast Asian region are among the world's highest producers of fish and fishery products from capture fisheries that come from the waters identified by FAO as major fishing areas (**Figure. 1**). In 2014, the world's fisheries production totaled 195.7 million metric tons (MT) of which 94.6 million MT was contributed by capture fisheries while 101.1 came from aquaculture (SEAFDEC, 2017). Of this total, the Southeast Asian region accounted for about 22% (42.2 million MT) with Indonesia as the region's highest producer generating about 20.6 million MT (SEAFDEC, 2017). With this scenario, effective management of the region's inland and coastal areas as well as its oceans is therefore necessary to enhance the production trend of fisheries and aquaculture in Southeast Asia and ensure food security for peoples not only in the Southeast Asian region but also in the whole world.

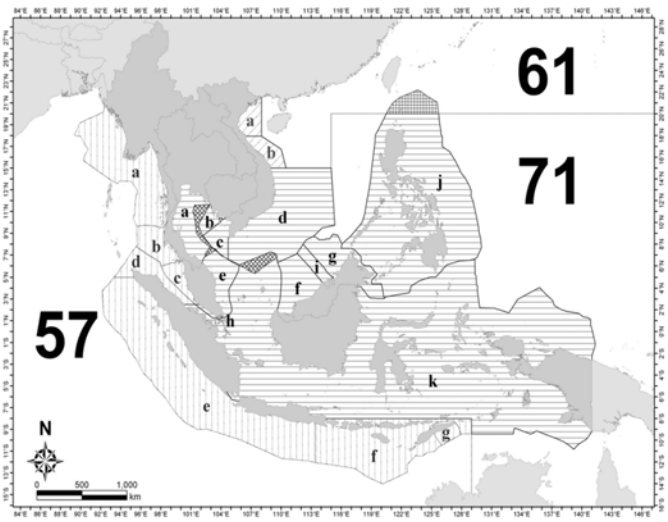

Figure 1. FAO Major Fishing Areas in Southeast Asia (SEAFDEC, 2008)

There are existing technologies that could be used for better planning and management of fisheries and aquaculture, *e.g.* GIS and RS technologies. The usage of these technologies is therefore worth exploring, especially in obtaining the necessary information for formulating appropriate approaches, policies, as well as management plans for medium and long-term sustainable utilization of fishery resources and environmental facilities for fisheries and aquaculture.

GIS and RS Technologies

GIS can be in the form of computer hardware, software, and data that allows any trained staff to update, manipulate, analyze, and display geographically the referred information (Rahel, 2004). Since GIS integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information, it can provide the unlimited amount of information needed in research (Foote and Lynch, 2015). **Box 1** presents the numerous GIS resources that are available online.

In fact, GIS has many applications related to planning, management, transport/logistics, insurance, telecommunications, and business (Maliene *et al.*, 2011). The application of GIS has various advantages as shown in **Box 2**. Foote and Lynch (2015) added that the numerous innovations, one of which is the use of the GIS, could boost the region's efforts to improve fisheries development and management as it could link a number of technologies, thus emerging as a powerful technology. During the development of the technology, researchers are assured that they could integrate their data and methods

Box 1. GIS Resources

GIS Resources

- *http://www.agi.org.uk* - Association for Geographic Information
- *http://www.wiley.com/legacy/wileychi/longley/* - Companion website to Geographical Information Systems and Science textbook
- *http://www.gis.com*
- *http://www.tandf.co.uk/journals/tf/13658816.html* - The International Journal of Geographical Information Science
- *http://www.ncgia.ucsb.edu/gissc/* - The NCGIA core curriculum in GIScience
- *http://www.rgs.org* - The RGS-IBG Geographical Information Science Research Group
- *http://www.ucgis.org* - University Consortium for Geographic Information Science

Softwares

- ESRI – *http://training.campus.com*
- Google Earth - *http://earth.google.com/intl/en/userguide/v4/tutorials/index.html*
- Digital Worlds - *http://www.digitalworlds.co.uk/*
- Ordnance Survey: *http://www.ordnancesurvey.co.uk/oswebsite/education/mappingnews/previouseditions/33/p38-39.pdf*

Databases

- Ordinance Survey (maps) - *http://www.ordnancesurvey.co.uk*
- Office of National Statistics (socio-economic variables) - *http://www.statistics.gov.uk*
- English Nature (landcover datasets) - *http://www.english-nature.org.uk/pubs/gis/GIS_Register.asp*
- British Geological Survey (small scale bedrock and deposit maps) - *http://www.bgs.ac.uk/products/digitalmaps/data_625k.html*
- Earth Science Data Interface (satellite data) - *http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp* (satellite data can be very demanding to set up)
- Street map (useful postcode information) – *http://www.streetmap.co.uk*

Box 2. Advantages in the application of GIS

1. **Cost savings from greater efficiency**
   GIS is widely used to optimize maintenance schedules and daily fleet movements. Typical implementations can result in a savings of 10-30% in operational expenses through reduction in fuel use and staff time, improved service with a more efficient scheduling.
2. **Better decision making**
   GIS is a technology for making better decisions about location. Common examples include real estate site selection, route selection, evacuation planning, conservation, natural resource extraction, etc.
3. **Improved communication**
   GIS-based maps and visualizations greatly assist in understanding different situations. They are a type of language that improves communication between different teams, departments, disciplines, professions, fields, organizations, and the public.
4. **Better record keeping**
   Many organizations have a primary responsibility of maintaining authoritative records about the status and change of geography. GIS provides a strong framework for managing these types of records with full transition support and reporting tools.
5. **Managing geographically**
   GIS is becoming essential to understanding what is happening and what will happen in geographic space. Once it is understood, appropriate actions could be prescribed.

in ways that support traditional forms of geographical analysis, such as map overlay analysis as well as new types of analysis and modeling that are beyond the capability of manual methods. With the application of GIS, it is now possible to map, model, query, and analyze large quantities of data all held together within a single database (Foote and Lynch, 2015).

Correspondingly, a technology using satellite or aircraft-based sensor technologies known as RS is used to detect and classify objects on earth, including those on the surface as well as in the atmosphere and oceans, based on propagated signals (*e.g.* electronic radiation). The instruments used in RS are passive and active instruments (Earth Observatory, 2018). Passive instruments are those that are used to detect natural energy that is emitted from observed source, such as reflected sunlight. The most common passive RS instruments include: radiometer, imaging radiometer, spectrometer, spectroradiometer. While active instruments are those used to illuminate the objects observed using the electromagnetic radiation they provide. The most common active remote sensors include: radio detection and ranging (radar), scatterometer, light detection and ranging (lidar), and laser altimeter.

Application of GIS and RS in Fisheries

In applying GIS to fisheries research, Simpson (1992) suggested that through remote sensing, much data could be generated for GIS applications. The application of GIS in marine environmental research started in the 1980s, when GIS was used as means of locating new sites for

mariculture (Mooneyhan, 1985; FAO, 1989). During the early phase of using GIS in fisheries, RS was used to generate marine environmental data relevant for GIS applications.

These data are useful for monitoring fishing effort, tracking pollutants, mapping bathymetry and sea bed habitats, and providing measurements of physical and biological properties in the water column (Carocci *et al*., 2009). For studies on the environmental properties of the oceans, Stuart *et al*. (2011) indicated that the use of RS could provide the overall picture on fish distribution, abundance, migration, and other information necessary for the monitoring and management of the ocean ecosystems.

After mid-1990s, the applications and uses of GIS in fisheries grew rapidly with expanded applications (Meadan, 2001), such as constructing spatially explicit models for fish habitat suitability, especially for mapping the mangrove areas, estuaries, sea grass beds, bottom sediments among others (Carocci *et al*., 2009). Nowadays, there are a number of GIS applications available, ranging from high-power analytical software (or desktop GIS, *e.g.* ArcGIS software) to web-based applications (*e.g.* online ArcGIS, Google Earth).

While the application of GIS in fisheries-related research is increasing, Carocci *et al*. (2009) mentioned four studies with GIS applications (**Box 3**) which could be used to exemplify the advantages of the use of GIS, especially in terms of addressing the various challenges, enhancing awareness and understanding of the GIS technology, displaying the various uses of GIS, utilizing various data sources, and the coverage which include different geographical areas and spatial scales. These examples could be used as references in carrying out GIS-related research in the fisheries sector of the Southeast Asian region.

In 2010, the Project "Societal Applications in Fisheries and Aquaculture using Remotely-sensed Imagery" (SAFARI) organized the International Symposium on Remote Sensing and Fisheries from 15 to 17 February 2010 in Kochi, India. The Symposium discussed the latest developments in RS applications, and the output of which could be used to enhance the application of RS in fisheries and aquaculture research, and especially in the development of potential fishing zones (Stuart *et al*., 2011). It should be noted however, that as recommended during the abovementioned Symposium, the use of RS for the assessment of potential fishing zones (PFZs) should be considered as the most appropriate approach for an

Box 3. Case studies on the application of GIS in fisheries-related research

Optimum time to release juvenile chum salmon into the coastal waters of northern Japan

Considering the decline in salmon stocks worldwide, release of hatchery-reared salmon juveniles into the coastal environment has also been considered by Japan as an economical strategy to address such concern. Miyakoshi *et al*. (2007) used remote sensing data to establish the sea surface temperature which was related to the date of juvenile release as well as the site of release. Results of the GIS-based analysis showed that salmon production, indicated by salmon returns, could be optimized when sea temperature range between 8°C and 13°C and when the juveniles are > 5 cm in length. Such results could provide the maximum benefits from fish stocking operations.

Identification of essential fish habitat for small pelagic species in Spanish Mediterranean waters

Small pelagic fishes such as sardines and anchovies are economically-important species in the Mediterranean coast of Spain. The development of a model that would give the optimum relationship between abundance and location of the species stocks was therefore deemed necessary to define the essential fish habitats (EFH) of the species (Bellido *et al*., 2008). Using environmental variables such as bathymetry, sea surface chlorophyll-a, and sea surface temperatures, the results indicated a substantial inter-annual variability in the distribution and quality of the EFH, which is crucial for the management of these local marine resources.

Development of GIS system for the marine resources of Rodrigues Island

Located in the Indian Ocean and about 600 km from Mauritius, Rodrigues Island is like any tropical island, under pressure from natural resource exploitation and increased tourism activities. The absence of standard information on the marine resources in the Island had hampered the management of the available marine resources. In 2000, a GIS-system was developed (Chapman and Turner, 2004) where the data on the distribution of biodiversity was integrated with the environmental factors controlling the distribution of such resources as well as the human activities such as fishing and conservation activities. A biotope mapping was carried out based on satellite imagery and ground truthing of the waters surrounding the entire Island. The results led to the designation of marine protected areas and development of marine resource conservation measures.

Influence of closed areas on fishing effort in the Gulf of Maine

There had been variety of problems associated with the establishment of closed areas to fishing, which could include "boundary" and "displaced effort" effects, which were also noted in the Gulf of Maine in the Atlantic Ocean off the coasts of Maine, New Hampshire and Massachusetts in the United States of America. Murawski *et al*. (2005) compared fishing effort distribution data for 1990-1993 (pre-area closure) with the effort for 2003 (post-area closure) and concluded that the 2003 effort had been concentrated and about 10% of total effort was deployed within 1.0 km of the closed area boundaries. They added that effort concentration varies in the different closed areas which implied that different fishing densities are related to habitat sustainability, and that there had been positive effect in some closed areas, especially in terms of increased revenues.

Box 4. Projects utilizing the GIS and RS technologies to support sustainable development and management of capture fisheries in Southeast Asia

EcoGIS Project

In 2004, the project "GIS Tools for Ecosystem Approaches to Fisheries Management" (EcoGIS) was launched through a collaborative effort between NOAA's National Ocean Service (NOS) and National Marine Fisheries Service (NMFS) and four regional Fisheries Management Councils. The project investigated how GIS, marine data, and custom analysis tools can enable fisheries scientists and managers to adopt the Ecosystem Approach to Fisheries Management (EAFM). The project focused on four main areas: (1) fishing catch and effort analysis; (2) area characterization; (3) bycatch analysis; and (4) habitat interactions.

SAFARI Project

Funded by the Canadian Space Agency (CSA), the project "Societal Applications in Fisheries and Aquaculture using Remotely-sensed Imagery" (SAFARI) was carried out in 2007 to facilitate international coordination on the application of rapidly evolving satellite technology to fisheries management. In 2010, the first SAFARI International Symposium was organized with contribution from the Indian Space Research Organization and Ministry of Earth Science on the development of potential fishing zones (PFZs) using satellite information. The Symposium provided a platform for deliberations on the latest developments in the field of RS in relation to fisheries with various case studies using satellite technologies for earth observations.

Fisheries Component of the UNEP/GEF South China Sea Project (SCS Project)

The South China Sea Meta-Database was developed by the SCS Project in 2002 (Paterson and Cooper, 2006) with contributions from national governments, academic institutions, and non-government organizations in Cambodia, China, Indonesia, Malaysia, Philippines, Thailand, and Viet Nam. The data set in the meta-database of the SCS Project used information on coastal habitats and resources including sea grass beds, mangroves, wetlands, fisheries, and land-based pollution. This database can be used as a search tool for identifying environmental and fisheries data sets of the area covering South China Sea and the Gulf of Thailand sub-region where the meta-data set from the search can be summarized and downloaded. The SCS Meta-Database can be applied to other projects/initiatives to avoid duplication of effort and resources. In addition, the SCS Project collaborated with the Southeast Asian Regional Learning Center (SEA-RLC), a regional initiative of the global GEF-funded International Waters Project, as well as with the Regional Center for the Southeast Asian System for Analysis, Research and Training (SEASTART RC) to develop the SCS GIS-based data and information (*http://metadata.unepscs.org/metadata*).

ecosystem-based fisheries management to ensure that overfishing does not take place.

In capture fisheries, a number of common issues such as fishing capacity (in terms of fishing vessels, efforts), deterioration of habitats, greenhouse gas emissions from the use of fossil fuels (believed to add impact to global climate change), could be addressed through the use of satellite remotely sensed (SRS) information and vessel monitoring system (VMS) technology, *e.g.* for management of skipjack tuna fisheries in the western North Pacific (Saitoh, 2011). In pelagic fisheries, Saitoh (2011) also reported that there are two aspects in the operational application of the SRS, *i.e.* (1) for identifying PFZs based on the relationship between target species and environmental factors; and (2) for developing the management measures particularly minimizing the bycatch of aquatic endangered species. He also reported that simultaneous analyses of VMS and SRS data could be used to improve operational fishery forecasting models and management measures, *e.g.* in the design of dynamic marine protected areas or to control fishing effort. For the Southeast Asian region, the applications of GIS and RS have supported the sustainable development and management of capture fisheries, some examples of which are shown in **Box 4**.

Key Issues and Challenges

It is likely that currently there are only few regional/national initiatives in Southeast Asia that apply GIS and RS technologies in fisheries. Prior to the application of GIS and RS technologies to fisheries, Nishida (1994) examined the progress on the use of GIS for spatial analysis of the marine fishery resources, and summarized the major challenges as shown in **Box 5**. Although raised in the 1990s, these concerns have not yet been fully addressed, especially in the fisheries of the Southeast Asian region.

When the First International Symposium on GIS in Fisheries Science was organized in 1999, various papers on GIS applications for marine fisheries were presented in different thematic areas, *i.e.* fisheries oceanography/habitats, fisheries resource analysis, remote sensing and acoustics, ecosystems/forecasting, estuary and coastal management, general review, concepts, education, research in progress, and software/database/computer system (Nishida *et al*., 2001; Nishida *et al*., 2004; Nishida *et al*., 2007). Moreover, GIS-based applications had also been promoted in various fora through seminars, conferences, workshops and the like, as well as in publications and scientific journals. However, in spite of such development, GIS applications in fisheries remains

Box 5. Major challenges for GIS applications in the spatial analyses of marine fishery resources (Nishida, 1994)

1. **Data**
   - Standardization of data collection structures with adjustment for discrepancies in space or time
   - Conversion of analog data to digital data
   - Consolidation of data gathering and databases
   - Automation of data collection
   - Establishment of simple database linked to GIS platform
   - Consideration of 3D or 4D database for GIS
   - Development of easy methods to access oceanography and satellite information
   - Development of easy methods to process matrix (raster) information
2. **Presentation**
   - Application of enhanced visualization to fisheries GIS
   - Effective and easy ways to present 3D and 4D parameters of fisheries and oceanography information such as catch, CPUE, temperature, and salinity
3. **Stock assessment, prediction, and spatial numeral analyses**
   - Development of linkages between GIS and stock assessment
   - Applying GIS methods, models, simulation, and geo-statistics in a fluid, dynamic 3D environment
   - Development of space oriented prediction methods for fishing and oceanographic conditions
4. **Fisheries management using GIS**
   - Space oriented fisheries management
   - Ecosystem-based fisheries management
   - Essential fish habitats and marine reserves
   - Fishing effort monitoring systems using global positioning system (GPS) and vessel monitoring system (VMS)
   - Fisheries impact assessment (development of space-based stock assessment)
   - Spatial allocation of the results of stock assessments such as MSY and TAC
   - Monitoring and modeling of quota arrangements
5. **Software**
   - Development of user-friendly and high performance fisheries GIS software that can handle simple parameters and also satellite information, and that can perform simple mapping as well as complex integrated spatial numerical analyses
6. **Human interaction**
   - Establishment of the international fisheries GIS association for networking to exchange ideas and information
   - Collaborative and interactive GIS activities in fisheries resource research by fisheries scientists, oceanographers, fishers and fisheries managers for effective, meaningful, and realistic achievements
   - Fostering a trustful relationship between researchers, fishers, and politicians

at its infancy stage mainly because of the fragmented nature of the fisheries (Meadan, 2001).

Nonetheless, after about two decades of using GIS for the spatial analysis of the fishery resources, some progress had already been achieved, especially in temperate countries but may be not yet in the Southeast Asian scenario because of the abovementioned challenges. Once these challenges are overcome, then GIS will have achieved its significant usage especially in advancing the management of the fishery resources in Southeast Asia.

In a survey of relevant publications issued before 2000, Fisher (2007) noted that most of the publications were qualitative in nature and involved jingle parameters with a few that dealt with multiple parameters although there were some which made use of the quantitative methods. Recently, when Fisher (2007) analyzed the latest publications, he found out that contents of more recent publications now included multiple parameters that adopted the geostatistical techniques, and added that the main thematic areas of fisheries-related research that utilize GIS applications include: habitat mapping, species distribution and abundance, fisheries oceanographic modeling, fishers' activities, and fisheries management.

Considering that fishing activities occur in a large extent of geographical area including inland, coastal, and marine waters, it is necessary to apply spatial analytical methodologies to enhance the management of these ecosystems for sustainable fisheries. Specifically for the sustainable development and management of capture fisheries in the Southeast Asian region, the application of GIS and RS technologies could play prominent role. However, there are key issues and challenges that need to be addressed. These concerns and the possible and suggested applications of GIS and RS are based on regional, sub-regional, and national initiatives in Southeast Asia (**Box 6**).

Way Forward

Applications of GIS and remote sensing technologies are essential to delineate the current condition of fishery resources and to provide information for better harvesting strategy. GIS application is effective for monitoring the

Box 6. Suggested applications of GIS and remote sensing to address the challenges encountered in the development and management of Southeast Asian fisheries		
Key Issues/Challenges	**Recommended Application of GIS and Remote Sensing Technologies**	**Objectives/Remarks**
Fishing vessels and fleets management	• Vessel monitoring system (VMS) using remote sensing technology for position and speed of the registered fishing vessels at sea • Database for licenses of fishing vessels and fishing gear	• Monitoring of the activities of fishing vessels at sea (currently applied mainly for commercial fishing vessels) • Monitoring the changes in the number of fishing vessels and fishing gears
Conservation and management of fishery resources and habitats in inland, coastal, and marine waters	• GIS-based mapping - Fishery resources (including location and abundance) and habitats - Bathymetry and deep-sea habitats - Fisheries/habitat management, fishing zones, fishing seasons, marine protected areas, fishery refugia, etc. - Oceanographic data (biological, physical, and chemical information, *i.e.* chlorophyll-a, sea surface temperature, salinity, wind, wave, etc.)	• Providing information on inland, coastal, and marine fishery resources of the region that would correspond to in situ data collection for further analysis
Improved collection system for catch and landing data for small-scale and commercial fishing	• Calculation of CPUE and Landing Per Unit Effort (LPUE) and data analysis using ArcGIS and MS Access	• Monitoring the fishing effort by tracking and collecting data on fishing seasons, fishing grounds, and number of fishing vessels and fishing gears used in specified fishing areas, period, etc.
Development of national/sub-regional management plan/policy	• Combination of recommendations in items 1 to 3	• Facilitating and/or developing the appropriate/agreed management plans and policies for fisheries and habitat conservation and management
Traceability of fish and fishery products	• Combination of recommendations in items 1 to 3	• Applicable to the ongoing regional and sub-regional initiatives in the region, *i.e.* ASEAN Catch Certification System (ACDS) and the electronic ASEAN Catch Certification System (eACDS)
Ecosystem Approach to Fisheries Management (EAFM)	• Combination of recommendations in items 1 to 3 and others	• Understanding and improving the performance of EAFM in specific areas • Integrating EAFM with ArcGIS software • Providing information and supporting fisheries management decision-making
Fishery Resources and Habitat Enhancement	• GIS-mapping of fishery resources and aquatic habitats	• Conserving and managing natural habitats and fishery resources for sustainable development and utilization

fishing effort in order to control the harvest/fishing effort level in certain highly exploited fishing grounds.

Moreover, RS technology is useful for forecasting fishing grounds to reduce the inefficiency of fishing activities, *e.g.* time travelling to/from fishing ground, energy consumed for fishing operation by the vessel (Haryo, 2016). Nevertheless, there are a number of areas where GIS and remote sensing could be applied for the sustainable development and management of fisheries in the Southeast Asian region, *e.g.* for the management of fishing capacity and combating IUU-fishing. In addition, by linking real-time information on fishing vessels movement at sea and vessels registration, and the shared information among the countries concerned on landing and fisheries management measures, GIS-based mapping could serve as a useful tool for managing various sources of important information that could be used as basis for formulating appropriate management monitoring, control, and surveillance (MCS) programs.

In this connection, SEAFDEC is now promoting the application of electronic system for traceability of fish and fishery products of the AMS whereby the regional fisheries database together with real-time information *via* RS technology could be used to trace the origin of fish and fishery products throughout the supply chain. Recently, SEAFDEC has facilitated the development of a joint management plan for transboundary fish stock through sub-regional programs including the waters of

Box 7. Future SEAFDEC projects that would make use of GIS and remote sending technologies

SEAFDEC-Sida Collaborative Project

Referring to activities implemented under the SEAFDEC-Sida Collaborative Project (2017-2019), one of the outputs includes development of GIS-based map for the management of transboundary species in the Gulf of Thailand and the Northern and Southern Andaman Sea. There are three main transboundary species in the Gulf of Thailand, *i.e.* anchovies, Indo-Pacific mackerel, and blue swimming crab. In the Andaman Sea, the transboundary species are neritic tunas (longtail tuna and kawakawa), anchovies, and mackerels (Indian mackerel and Indo-Pacific mackerel). Information inputs from the countries in the Gulf of Thailand and the Andaman Sea sub-regions include data on catch and landing, migratory pattern of transboundary fisheries resources, abundance of fish larvae and area distribution in each monsoon season of the year, fishing efforts (CPUE, number of fishing vessels targeting to catch the target transboundary species), monsoon pattern, environmental information (coastal and marine environment and habitats). This information will be compiled and agreed among the countries whereby the development of a joint management plan for such transboundary species will be based upon the results of data analysis using GIS-based mapping.

Strengthening the Effective Management Scheme with GIS and Remote Sensing Technologies for Inland Fisheries and Aquaculture

SEAFDEC has proposed to Japan-ASEAN Integrating Fund (JAIF) to support the ASEAN Member States (AMSs) in strengthening their respective fisheries management using GIS and remote sensing technologies. With 1-year period of implementation and scheduled to start in 2019, this proposal was developed based on the assumption that information on the environmental changes of various factors in the habitats and aquatic ecosystems affecting the utilization of inland fishery resources, has yet to be sufficiently obtained. This 1-year project will be implemented by collecting catch data at selected fishing grounds of the participating countries to be digitized together with environmental information (geographical and inland water aquatic organisms' habitats based on satellite images obtained from that target sites). All information will be compiled and analyzed by the applications of GIS and remote sensing technologies. The final output from the data analysis could include levels of impact from environmental factors and changes on the inland fishery resources that could be used for effective improvement of inland capture fisheries management.

the Gulf of Thailand and the Andaman Sea by applying GIS-based mapping. Regarding the development of GIS-based mapping for coastal and marine fisheries resources management, SEAFDEC with the financial support from Swedish Government has also initiated sub-regional activities on establishment of a MCS network and management whereby the issues on transboundary fishery stock in sub-regional waters of the Gulf of Thailand and Andaman Sea was initially discussed among countries concerned. In addition, SEAFDEC proposed a new project "Strengthening the Effective Management Scheme with GIS and Remote Sensing Technologies for Inland Fisheries and Aquaculture" which would also make use of the GIS and Remote Sensing Technologies. Details of these two projects are shown in **Box 7**.

References

Bellido, J.M., Brown, A.M., Valavanis, V.D., Giraldoz, A., Pierce, G.J., Iglesias, M., and Palialexia, A. 2008. Identifying essential fish habitat for small pelagic species in the Spanish Mediterranean waters. Hydrobiologia 612 (1): 171-184

Carocci, F., Bianchi, G., Eastwood, P. and G. Meaden. 2009. Geographic Information Systems to support the ecosystem approach to fisheries. FAO Fisheries and AquacultureTechnical Paper No. 532. Rome, FAO. 2009. 120 p

Chapman, B. and Turner, J.R. 2004. Development of a Geophysical Information System for the marine resources of Rodrigues. Journal of Natural History 38: 2937-2957

Earth Observatory. Available at *https://earthobservatory.nasa.gov/Features/RemoteSensing/remote_08.php*. Accessed on 23 May 2018

FAO. 1989. Report of the FAO Asian Region Workshop on Geographical Information Systems Applications in Aquaculture. FAO Fisheries Report 414. Rome; 13 p

Fisher, W.L. 2007. Recent trends in fisheries geographic information systems. ***In***: T. Nishida, P.J. Kailoka, A.E. Caton (eds). GIS/Spatial Analysis in Fishery and Aquatic Sciences. Vol. 3. Fishery-Saitama, Japan, Aquatic GIS Research Group; pp 3-20

Foote, K and Lynch, M. 2015 Geographic Information Systems as an Integrating Technology: Context, Concepts, and Definition. The Geographer's Craft Project, Department of Geograph; The University of Colorado at Boulder, Colorado, USA

Haryo, T.Y. 2016. GIS and Remote Sensing Application in Capture Fisheries: Fishing Effort Analysis and Fishing Ground Forecasting. Concept of GIS and Remote Sensing. ***In***: NRS 509 - Concept of GIS and Remote Sensing. December 15, 2016; 10 p

Maliene V, Grigonis V, Pelevicius V., Griffiths S. 2011. Geographic Information System: Old Principles with New Capabilities. Urban Design International 16, 1–6. doi:10.1057/udi.2010.25

Meadan, G.J. 2001. GIS in fisheries science: Foundations for the new millennium. ***In***: Nishida, T., Kailola P.J. and Hollingwoth CE (eds). Proceedings of the First International Symposium on GIS in Fishery Science. Eattle, Washington, USA; 2-4 March 1999; pp 3-29

Miyakoshi, Y., Saitoh, S., Matsuoka, A., Takeda, M., Asamo, H., Fujiwara, M. and Nagata, M. 2007. Comparison of release timing of hatchery-reared juvenile chum salmon (*Oncorhynchusketa*) to spring coastal sea surface temperatures during high and low survival periods. ***In***: T. Nishida, P.J. Kailoka, A.E. Caton (eds). GIS/Spatial Analysis in Fishery and Aquatic Sciences. Vol. 3. Fishery-Saitama, Japan, Aquatic GIS Research Group; pp 227-240

Mooneyhan, W. 1985. Determining aquaculture development potential via remote sensing and spatial modelling. In: Report of the Ninth International Training Course on Applications of Remote Sensing to Aquaculture and Inland Fisheries. RSC Series 27. FAO, Rome, Italy; pp 217-237

Murawski, S.A., Wigley, S.E., Fogarty, M.J., Rago, P.J. & Mountain, D.G. 2005. Effort distribution and catch patterns adjacent to temperate MPAs. ICES Journal of Marine Science 62: 1150–1167

Nishida,T. 1994. Spatial Fish Resources Analysis Using GIS (Geographical Information Systems): Current Situation and Prospects. Journal of Japan Science and Technology Information Aggregator, Electronic; pp 109-112

Nishida, T, Kailola, P.J. and Hollingworth, C.E. (eds). 2001. Proceedings of the First International Symposium on GIS in Fishery Science. Saitama, Japan, Fisheries GIS Research Group

Nishida, T, Kailola, P.J. and Hollingworth, C.E. (eds). 2004. GIS/Spatial Analyses in Fishery and Aquatic Sciences. Vol. 2. Saitama, Japan, Fishery-Aquatic GIS Research Group

Nishida, T., Kailola, P.J. and Caton, A.E. (eds). 2007. GIS/Spatial Analyses in Fishery and Aquatic Sciences. Vol. 3. Saitama, Japan, Fishery-Aquatic GIS Research Group

Paterson, C. and R. Cooper. 2006. Building an Online Collaborative Database for Fisheries Habitats Management in Southeast Asia – The South China Sea Meta-Database. ***In***: Fish for the People, Vol. 4, No. 1: 2006. Southeast Asian Fisheries Development Center, Bangkok, Thailand; pp 28-31

Rahel F. 2004. Introduction to Geographic Information Systems in Fisheries. American Fisheries Society, Bethesda, USA; pp 1–12

Saitoh S. 2011. Some Operational Uses of Satellite Remote Sensing and Marine GIS for Sustainable Fisheries and Aquaculture. CIES Journal of Marine Science, Vol. 68, Issue 4; pp 687-695

Saitoh, S. I., R. Mugo, I. N. Radiarta, S. Asaga, F. Takahashi, T. Hirawake, Y. Ishikawa, T. Awaji, T. In, and S. Shima. 2011. Some operational uses of satellite remote sensing and marine GIS for sustainable fisheries and aquaculture. ICES Journal of Marine Science 68: 687-695

SEAFDEC. 2008. Regional Framework for Fishery Statistics of Southeast Asia. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 33 p

SEAFDEC. 2017. Southeast Asian State of Fisheries and Aquaculture 2017. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 167 p

Simpson, J.J. 1992. Remote sensing and geographical information systems: Their past, present and future use in global marine fisheries. Fisheries Oceanography. Volume 1 Issue 3, September 1992; pp 238-280

Stuart, V., Platt, T., Sathyendranath, S., and Pravin, P. 2011. Remote sensing and fisheries: an introduction. – ICES Journal of Marine Science, 68: 639–641

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Using Yield per Recruit Analysis to Determine Fish Stock Status

Supapong Pattarapongpan

During the past decade, the fishing industry in Southeast Asia had been confronted with concerns on declining fishery resources due to overfishing, and more particularly because of the continued practice of illegal, unreported, and unregulated (IUU fishing) as well as degradation of the habitats that bring about negative impacts to the economic, social and ecological attributes of fisheries affecting food security. It has therefore become necessary that management measures should be established for the sustainable management of the fishery resources in general. However, attempts to establish such fisheries management measures have encountered problems on inadequacy of data for stock assessment that hinder the efforts to develop such measures. During discussions on the sustainable utilization and management of fishery resources in the Southeast Asian region, the need to improve data collection had always been raised on various occasions for the development of appropriate management measures of the fishery resources. Many studies have indicated that the use of Yield per Recruit Analysis could be an option in determining fish stocks, especially in situations where historical data in time series is insufficient. In this connection, a pilot study using Yield per Recruit Analysis was carried out in Sakon Nakorn Province, Thailand, to determine the stock status of the beardless barb in Nam Oun Reservoir. Results of such study could be used as model in the development of the appropriate management measures for the sustainability of the fishery resources of Southeast Asia.

In Southeast Asia, insufficiency of fisheries data is one of the main concerns in fisheries management and stock assessment (FAO, 2010). In a review of the information and data available during a regional workshop organized in 2009 by the WorldFish Center, FAO and SEAFDEC, and participated in by representatives from the ASEAN Member States (AMSs), it was noted that problems on data availability for short-time assessment were observed not only for cartilaginous fish stocks such as sharks but also for bony fish stocks. During the series of consultations organized by the SEAFDEC Training Department (TD), it was recommended that the "Yield per Recruit Analysis or Y/R Analysis" could be used to monitor the stock status of fishery resources in the Southeast Asian region considering the insufficiency of time series production data.

There are several models and concepts that could be adopted to determine the biomass of certain fish stocks, the most popular of which is the "Prediction Model" (Sparre and Venema, 1998), which involves predicting the stock biomass using a mathematical model that generates the possible number of catch, biomass and other related mortality parameters in the future based on the currently available data including economic data, such as price. For some models, the direct link between fish stock assessment and fish resource management as well as economic management, is eminent. The first Prediction Model proposed by Thompson and Bell in 1934 considered many assumptions but needed more data inputs. So, the model was not highly popular until computers were introduced. In the meantime, a simpler model known as "Yield per Recruit Analysis" was introduced by Beverton and Holt in 1957. Based on strict assumptions and requires less calculation, this model is more convenient to use in real situations. In this model, 'yield' refers to the amount of utilized fishery resource that focuses only on target species, different from 'catch" which includes yield, bycatch and catch from ghost fishing.

Yield per Recruit Analysis

Sparre and Venema (1998) provided the assumptions for the Yield per Recruit Analysis (Y/R Analysis) as shown in **Box 1**, and considered that during the early life span of fish, it is hatched from eggs in large numbers at the same time and also enter the fishing ground at the same time, as well as at the same age during recruitment (T_r). This is represented as "number of recruitment" or "R" while the rapidly increasing number is called "knife-edge recruitment" as shown in **Fig. 1**. During such time, R can

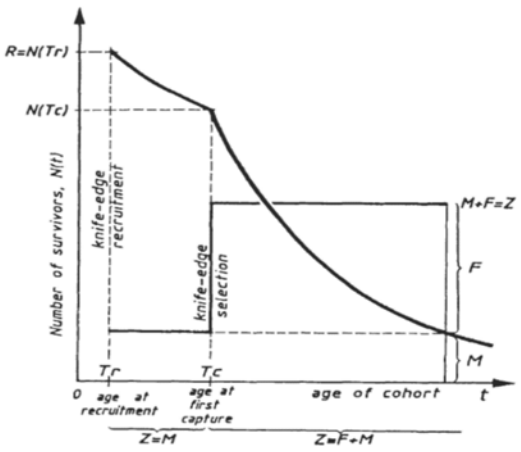


Fig. 1. Knife-edge pattern as knife-edge recruitment (*dashes*) and knife-edge selection (*dark line*) (Adapted from Sparre and Venema (1998))

Box 1. Assumptions used for the Yield per Recruit Analysis (Sparre and Venema, 1998)
• Fish population is assumed to be exploited in steady state
• Every individual in the same unit stock is assumed to be hatched at the same date and time, also called 'same cohort'
• Recruitment and selectivity patterns are 'knife-edge' also called 'big bang recruitment pattern' wherein the large number of recruitment will enter the fishing ground at the same time and the number of fish size in the selectivity range will increase rapidly at the same time
• During exploitation stage, natural mortality (M) and fishing mortality (F) are constant so that the environmental condition and fishing effort should be constant
• Fishing mortality will change naturally depending on the size and age of fish but there will be very minor change in the low selectivity gear such as trawlers
• There is a perfect random mixing within stocks, where the individual born in the early and late hatching period is assumed to be the same cohort by ignoring the length of that period
• Isometric growth pattern is observed directly from the length-weight relationship equation, $W=qL^b$, when b = 3, but it is also possible to use species having allometric growth pattern (b ≠ 3), in which case the equation could be adjusted in terms of some values using some mathematical methods

be decreased only by natural mortality (M), generating in the process the number of the remaining stock which is shown as "N". After the fish gets bigger reaching a size at first capture (L_c) and age at first capture (T_c), N will be affected by fishing pressure, and the mortality of fish will become Z (total mortality) which is equal to M (natural mortality) + F (fishing mortality) causing rapid decrease of the stock, known as "knife-edge selection."

To determine the Yield per Recruit (Y/R), Beverton and Holt (1957) developed the Y/R equation which requires weight and age-based biological parameters together with mortality parameters as shown below:

$$\frac{Y}{R} = Fe^{(-M(t_c - t_r))} W_\infty \left[{}^1/_Z - {}^{3S}/_{(Z+K)} + {}^{3S^2}/_{(Z+2K)} - {}^{S^3}/_{(Z+3K)} \right]$$

Where Z=Total mortality (F+M per year);
F=Fishing mortality (per year);
M=natural mortality (per year);
t_c=age at first capture (year);
t_r=age at first recruitment (year);
W_∞=asymptotic weight (g); and
S=constant, which is derived using the equation:

$$S = e^{K(t_c - t_0)}$$

Where K=curvature parameter (per year),
t_c=age at first capture (year), and
t_0=hatching period (year)

The result of the Y/R equation could be interpreted as the yield (measured in weight) per number of recruitment (recorded in number). For example, if 1.0 million fish recruited give a yield about 1,000 metric tons (mt), then 2.0 million fish recruited should give yield of about 2,000 mt or yield of about 1.0 kg per one fish. The graph of Y/R equation reflecting different ages at first capture is shown in **Fig. 2**.

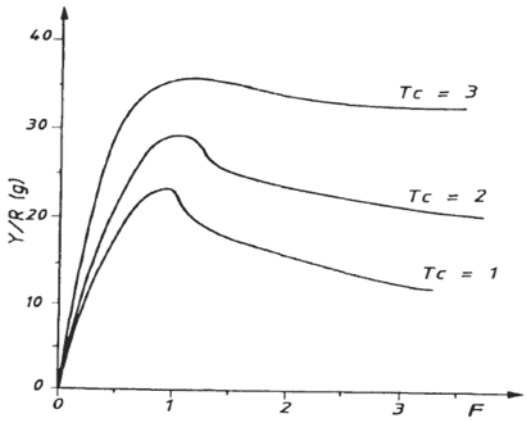


Fig. 2. Different curves of Y/R reflected by different ages at first capture (Adapted from Sparre and Venema (1998))

The graph of the Y/R could be presented in a curve showing the relationship between the yield per recruit (y-axis) and the fishing mortality (x-axis) as shown in **Fig. 3**. The optimum fishing mortality is represented by the Y/R forming a peak of the curve which is the 'MSY' level (Sparre and Venema, 1998). The peak of the curve is reflected by age at first capture (t_c).

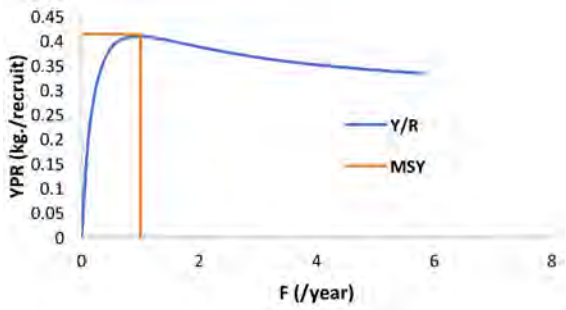


Fig. 3. Yield per recruit curve showing the peak of curve and MSY level

In monitoring the stock status of fishery resources, the main concern raised by fisheries researchers and managers during stock assessment is 'overfishing' which can be divided into two (2) levels, such as:

(1) *Growth overfishing:* Can occur when increase in fishing effort is too high, and fish is caught before they can grow old enough to be considered as a recruitment. Such situation is known as "overfishing in biological concept."

(2) *Recruitment overfishing:* Occurs when the resource reaches 'growth overfishing' but the fishing effort is still maintained or gets higher, and the fish caught gets smaller and the number of parental stock declines. In this level, if no appropriate management measures are in place, the species stock biomass could collapse or becomes extinct from the ecosystem.

In practice, Y/R Analysis is mainly used for evaluating the situation of a stock, *i.e.* whether it is in a state of 'growth overfishing' or not. Nevertheless, considering that data is limited over a long period of time, the occurrence of small amount of yield per recruit could imply that there is 'growth overfishing'. Therefore, Y/R Analysis could be an appropriate tool for this kind of situation and still be able to estimate the stock status and subsequently come up with the necessary management measures.

Y/R Analysis had been used in many studies aimed at determining the fish stock situation. For example, Peixer and Petrere Júnior (2007) mentioned in their study of the South American ray-finned fish "pacu" (*Piaractus mesopotamicus*) in Pantanal, Brazil. As one of the most important target species in Pantanal, Brazil, "pacu" had been reported to be over-exploited in Brazilian waters. Using the biological data and other biological parameters collected from sports fishing and teams of researchers, the length-weight relationship of "pacu" had been developed, while the mortality parameters were derived from fishery statistics during 1999-2000. The results based on the value of F confirmed that "pacu" in Pantanal waters was over-exploited.

In the Y/R study for greasy grouper (*Epinephelus tauvina*) carried out by Barr *et al*. (2010) in the Arabian Gulf waters of Qatar, the results provided that the catch of greasy grouper was over the MSY level. The study also confirmed that the increase in age at first capture is reflected directly with the peak of the Y/R graph and fishing mortality level as well. Therefore, the management strategy for this species of grouper focused on gear selectivity by age and size of target, while the management measure was based on the result of the Y/R Analysis.

In the case study carried out by Barbieri *et al*. (1997) on the Atlantic croaker (*Micropogonias undulatus*), a quick assessment was made by estimating the current F compared with F_{MSY} provided in the Y/R. The results indicated that the different size compositions in different study areas had also affected the result of the Y/R Analysis.

The use of Y/R Analysis is therefore quite useful in situations where the data is limited, such as those in Southeast Asia, as the model requires less input parameters which can be observed and collected easily through annual field surveys. However, this model should be interpreted carefully considering its assumptions while the data inputs should be collected carefully in order to get more significant results. Nonetheless, the Y/R Analysis remains one of the important choices for conducting regional stock assessment as reference point for the development of fishery management measures in the future.

Yield per Recruit Analysis of Beardless Barb (*Anematichthys repasson* (Bleeker, 1853)) in Nam Oun Reservour, Sakon Nakorn, Thailand: A Case Study

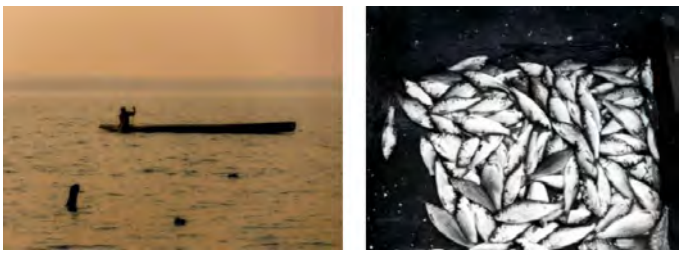
In a case study conducted by the SEAFDEC Training Department (TD) for the development of management measure for the beardless barb (*Anematichthys repasson*) in Nam Oun Reservoir, Sakon Nakorn, Thailand, the Y/R Analysis was adopted. Beardless barb is one of the most economically important species in Nam Oun Reservoir.

Beardless barb (*Anematichthys repasson*)

A member of Cyprindae family, this species is mainly distributed in Southeast Asia from Mae Khlong to Maekong River basin in areas between Thailand, Lao PDR, Cambodia and adjacent waters of Myanmar, while its southern range reaches part of Peninsular and Sarawak Malaysia, and Sumatra in Indonesia (Vidthayanon, 2012; Froese and Paully, 2018). This species is usually caught for household consumption and local market by artisanal fisheries. The status and trend of the fisheries of this species have not yet been determined, therefore, this report will be the first stock assessment of the beardless barb in Nam Oun Reservoir, Sakon Nakhorn Province, Thailand.

Based on the findings of Peixer and Petrere Júnior (2007), Y/R Analysis is the alternative model most applicable in cases where long time series data of catch and effort are unavailable. The Y/R equation of Beverton and

Holt Yield (Gulland, 1969, cited in Sparre and Venema, 1998) which explains about the relationship between the number of recruitment (expressed as number) and the possible yield that can be derived after recruitment or when virgin stock grows into exploited stock (as weight), was therefore used to generate the Y/R Analysis in the said case study. Following Sparre and Venema (1998), the result is reflected as the relationship between Y/R and other related models as biomass per recruit and fishing mortality (F) in each level. In this connection, Y/R offers a simple and clear way for managers involved in fisheries to take decisions regarding, for example, the advantages of reducing mortality rates and/or increasing the minimum age of recruitment for fisheries management, as suggested by Holden (1995 cited in Peixer and Petrere Júnior, 2007).



Fishing activity in Nam Oun Reservoir (left) and beardless barb yield (right)

Features of the Case Study

This study was aimed at generating the Y/R Analysis to monitor the status of the beardless barb in Nam Oun Reservoir, Sakon Nakhorn, Thailand, the result of which could be used as reference point for fisheries management of this important resource at Nam Oun Reservoir. The study made use of the Nam Oun fishery patrol monthly survey conducted under the collaborative resource enhancement project of the Department of Fisheries of Thailand, Nam Oun Fishery Patrol Unit and SEAFDEC/TD. The biological parameters as asymptotic length (L_∞) and curvature parameter (K), size at first capture, total mortality, and natural mortality were determined using the FAO-ICLARM Stock Assessment Tool version 2 or FiSAT II (Gayanilo *et al*., 1998). For the age-length key, von Bertalanffy's growth equation was used, as shown below:

$$L_t = L_\infty e^{-K(t-t_0)}$$

Where L_t=Length at age t (cm);
L_∞=asymptotic length (cm);
K=curvature parameter (per year);
t=age (year); and
t_0=hatching period (year), which could be calculated using the modified von Bertalanffy equation:

$$t_0 = \frac{1}{K}\ln\left(1 - \frac{L_0}{L_\infty}\right)$$

Where L_0=size at first hatching (cm)

The fishing mortality and natural mortality was derived from the function between monthly total mortality (Z) and total fishing effort. The trend was established using the equation:

$$Z=M+F$$

Where M=natural mortality coefficient (per year);
F=fishing mortality

The yield per recruit as a function of fishing mortality F, was calculated using Beverton and Holt (1957) as shown below:

$$\frac{Y}{R} = Fe^{(-M(t_c-t_r))}W_\infty\left[{}^1/_Z - {}^{3S}/_{(Z+K)} + {}^{3S^2}/_{(Z+2K)} - {}^{S^3}/_{(Z+3K)}\right]$$

Where t_c=age at first capture (year);
t_r=age at first recruitment (year); and
W_∞=asymptotic weight (g)

Data collection for stock assessment study

Results and Discussion

Growth

The length-weight equation of beardless barb was determined using unseparated sex, the result of which indicated that $W = 0.0351L^{2.908}$. The growth parameters calculated by FiSAT II gave the asymptotic length (L_∞) and curvature parameter (K) as 23.42 cm and 0.33 per year, respectively. The age-length parameter provides the growth curve for each data set which could be used to adjust the size at first capture from the record.

Using the samples of the beardless barb, the computation for age-length parameter indicated 10.04 cm which is a little bit bigger than the size at first maturity reported by Nuangsit and Chansri (2008) which was at 10.02 cm (**Table**). As of the moment however, only the growth parameter is available for this species, and there is still no exact information on age determination for the beardless barb. Therefore, age determination was considered based on the biological parameter, size at hatching time and hatching period, which was used as input in the computation of the age-length equation using the von Bertalanffy's equation.

Mortality estimation

For mortality estimation of the beardless barb, the equation of Jones and van Zalinge (1984) (cited in Sparre and Venema, 1998) was used to determine the total mortality while for natural mortality the equation of Pauly (1980) was used and both functions are presented in FiSAT II. The results showed the total mortality of the beardless barb at 1.88 per year and the natural mortality at 30°C surface temperature was 1.27 per year. However, beardless barb was not included in the species list of Pauly's research for natural mortality (Pauly, 1980). Therefore, the natural mortality for this species should make use only of 1 or 2 digits to avoid uncertainties. The fishing mortality was 0.92 per year.

Size at first capture

The size at first capture of beardless barb landed in Nam Oun Reservoir and nearby area was closed to the size at first maturity reported by Nuangsit and Chansri (2008), although the current information of this species is still limited. Therefore, further study should be carried out for better understanding of the status of the stock of this species.

Table. Size at first capture compared with size at first maturity

Size (TL, cm)	Sample	L_m (TL, cm)	References
$L_{25\%}$	9.25		
L_c	10.04	10.02	Nuangsit and Chansri (2008)
$L_{75\%}$	10.83		

Yield per Recruit Analysis

Results from the Y/R Analysis are shown as the Y/R curve and Kobe plot that made use of the ratio between F/F_{MSY} and TB/TB_{MSY}. For the beardless barb, the results indicated that the fishing mortality and Y/R at current level (orange dot) were 0.92 per year and 2.339 kg/recruit, respectively, while the value of MSY (green dot) was 4.40 per year and Y/R at 11.46 kg/recruitment (**Fig. 4**).

The values of F/F_{MSY} and TB/TB_{MSY} for the beardless barb were 0.21 and 3.98, respectively. Therefore, F is 79% lower than the MSY level, and TB is 298% higher than the MSY level, as shown in **Fig. 5**. The results also indicated that the growth parameters as asymptotic length (L_∞) and curvature parameter (K) were 23.42 cm and 0.33 per year, respectively. Furthermore, the results also showed that the size at first capture of the beardless barb landed in Nam Oun Reservoir and nearby area was 10.04 cm, which is closed to previously established size at first maturity of this species which was at 10.02 cm.

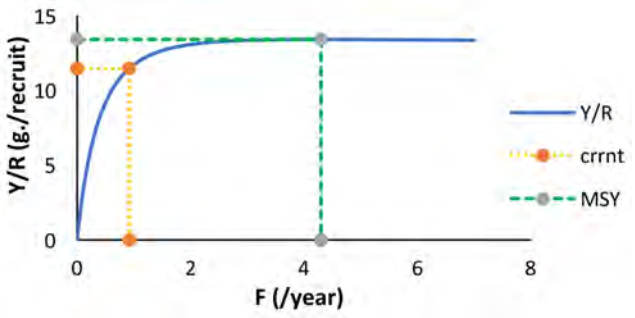


Fig. 4. Yield per recruit estimation with current situation (crrnt) and MSY level (MSY) for the beardless barb

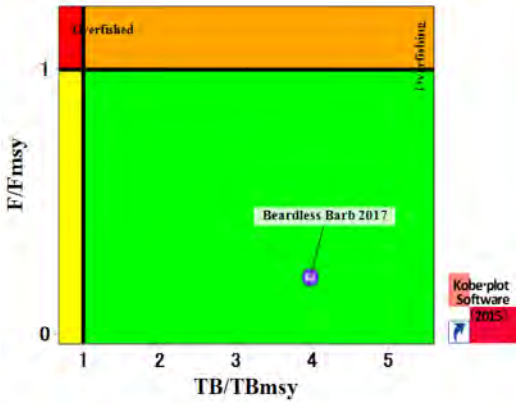


Fig. 5. Result from Kobe plot showing the current status of beardless barb based on the Y/R analysis

Results of the Y/R Analysis show that the population of beardless barb in Nam Oun Reservoir is in deep green zone (very good condition, TB/TB_{MSY} = 3.98 and F/F_{MSY} = 0.21). In Nam Oun Reservoir, the beardless barb is one of the important species for house-hold consumption and local market together with other barbs and inland fish species. The results from this study can therefore provide the appropriate reference point for the development of resource management measures for the fishery resources in this area.

Other Uses of Yield per Recruit Analysis

Considering that Yield per Recruit Analysis could be used not only for stock assessment of bony fishes but also for cartilaginous species such as sharks, the "Technical Consultative Meeting on Shark Data Collection and Stock Assessment and Improvement Data Collection in Southeast Asian Region" arranged by SEAFDEC/TD in September 2017, agreed to select "Yield per Recruit Analysis" as the most appropriate model to analyze the stock status of sharks caught in the Southeast Asian region by making use of the one-year data available at the moment. Four (4) species of economically-important species of sharks, namely: brown-banded bamboo shark (*Chiloscyllium punctatum*); grey bamboo shark (*C. hasseltii*); pelagic thresher (*Alopias plagicus*); and the bigeye thresher (*A. superciliosus*) had been identified for the proposed pilot study. Initially, the brown-banded bamboo shark would be considered for the pilot study not only in view of its importance for household consumption but also because the status and trend of the production of the species have not been determined yet (Krajangdara, 2017) and the species has been recognized by Dudgeon *et al*. (2016) as "near threatened" since 2003.

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References

Barbieri, L. R., M. E. Chittenden Jr. and C. M. Jones. 1997. Yield – Per – Recruit Analysis and Management Strategies for Atlantic Croaker *Micropogonias undulates*, in the Middle Atlantic Bight, **Fishery Bulletin**, vol. 95(4): 637-645

Barr, M. A. A., A. F. M El-Sayed and A. M. Osman. 2010. The Use of Per Recruit Models for Stock Assessment and Management of Greasy Grouper *Epinephilus tauvina* in The Arabian Gulf Waters off Qatar, **Tropical Life Sciences Research**, Vl. 21(1): 83-90

Dudgeon, C.L., Bennett, M.B. and Kyne, P.M. 2016. *Chiloscyllium punctatum*. **The IUCN Red List of Threatened Species** 2016: e. T41872A68616745. *http://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T41872A68616745*.en. Downloaded on 24 November 2017

FAO. 2010. Report of the first Workshop on Assessment of Fishery Stocks Status in South and Southeast Asia, 16 – 19 June 2009, **FAO Fisheries and Aquaculture Report**; 30 p

Froese, R. and D. Paully, 2018, Species 2000 & ITIS Catalogue of Life, Downloaded on 03 May 2018, Link: *http://www.catalogueoflife.org/col/details/species/id/678f3557f01f89b1ee03efe85dfa12ae/synonym/b5cbe3755dcbd70d283885373394190e*.

Gayanilo Jr., F. C., P. Sparre and D. Pauly. 1994. **The FAO-ICLARM Stock Assessment Tools (FiSAT) User's Guide**, FAO Computerized Information Series (Fisheries), Rome

Krajangdara, T. 2017. **The Cartilaginous Fishes (Sharks, Rays and Chimeras) Found in Thai Waters and the Adjacent Areas**, Marine Fisheries Research and Development Division, Department of Fishery, Ministry of Agriculture and Cooperative, Bangkok; 331 p

Nuangsit, S and P. Chansri, 2008, Reproductive Biology of Some Fishes in Lamtakong Reservoir, Nakhon Ratchasima Province, **Technical Paper**, Inland Fisheries Research and Development Bureau, vol 22/2008

Pauly, D. 1980. On the interrelationships between natural mortality, growth parameters, and mean environmental temperature in 175 fish stocks, **ICES Journal of Marine Science**, Vol. 39 (2); pp 175-192

Peixer and Petrere Júnior. 2007. Yield per recruit of the pacu *Piaractus mesopotamicus* (Holmberg, 1887) in the pantanal of Mato Grosso do Sul, **Brazilian Journal of Biology**, 63(3): 561-567

Saraphaivanich, K., N. Imsamran and Y. Suthipol. 2015. Form of IUU Fishing Activities Occurring in the Region, **Advance Fisheries Technology**, Vol. 7 (3)

Sparre, P. and S. C. Venema. 1998. **Introduction to Tropical Fish Stock Assessment, Part I, Manual**, FAO Fisheries Technical Paper, FAO, Rome; 407 p

Vidthayanon, C., 2012, *Cyclocheilichthys repasson*, **The IUCN Red List of Threatened Species 2012**, Downloaded on 30 May 2018, Link: *http://dx.doi.org/10.2305/IUCN.UK.2012-1.RLTS.T180861A1671282.en*.

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Beyond Capacity Adaptation – for what should it be adapted?

Jacob Hagberg

It is well known that keeping fish stocks at optimum stock sizes will increase the production of fish leading to larger profits for fishers and increased food production. The Southeast Asian countries have started to make efforts to adapt fishing capacity to the available amounts of fish. But the step to translate scientific recommendations into a practical change of the fishing effort is often the most sensitive, especially from decision making perspectives. Decision makers feel pressured to meet the demands of different interest groups, often sacrificing the long-term larger profits for more short-term smaller gains. One solution to simplify this process is to use Harvest Control Rules.

Many countries around the world are successfully using a legal tool called Harvest Control Rule (HCR) to agree in advance, how fishing effort should be adapted to the size of the fish stocks. By deciding on pre-determined rules for adapting the fishing effort, "Harvest Control Rules," takes away some political pressure to increase fishing and makes decisions transparent to the fishers and the public. An HCR is a short legal document that explains how fishing capacity or effort should be adapted depending on the result of a scientific assessment of the fish stocks. The target of HCR is often formulated to maximize fish production, which could indicate that fishing effort should be for example, equivalent to the Maximum Sustainable Yield (MSY) or that the biomass of a fish stock should reach **x** percent of the MSY by year **y**. An example of a simple harvest control rule could be:

> *"If a scientific stock assessment recommends to change fishing effort for the Indo-Pacific mackerel by **x** per cent to reach the target of the HCR, then number of gears licensed to fish the Indo-Pacific mackerel should be changed by **x** per cent."*

In practice, most fishing methods all over the world catch more than one species in what is called a mixed fisheries or multispecies fisheries. Such situations could also be handled by the HCR. Let's say we also catch anchovy when we fish for mackerel. If results of scientific stock assessment recommend that fishing effort for anchovy could be increased by 20 per cent but for mackerel it can only be an increase of 10 per cent, the HCR should be designed to handle this situation. The precautionary formulation of a HCR that handle a mixed fishery could be:

> *"If scientific assessments recommend different effort changes for different species caught by the same gear, then the number of gears should be changed in accordance with the most conservative change recommended for the species caught by the same gears."*

In this case, the HCR would lead to an increase of effort by only 10 per cent and an optimal harvest for mackerel but under-harvesting the anchovy since the recommendation was that anchovy could be increased by 20 per cent. The most un-precautionary approach would be to have the opposite approach of the HCR where effort is increased by 20 per cent and optimally utilizing anchovy, but could lead to overfishing of the mackerel. This would likely lead to a situation where the status of the mackerel stock is deteriorating for the next assessment, ultimately leading to a very bad situation for the mackerel. Normally, the precautionary approach leads to more stable stocks with less variation which is often preferable from the market and industry perspectives. **Box 1** shows an existing HCR which have been agreed between Norway and Russia. The two countries fish on a transboundary stock of cod in the North Atlantic. After the two countries agreed to follow this HCR, the catches have doubled and the fish stock has been stable at the MSY level.

HCR can also be designed to handle both a quota-based and effort-based systems. Between the two extremes presented above, there are other intermediate solutions where some deviations are acceptable from the target of, for example, the MSY, but the thresholds are decided under which the fishing effort must be reduced. See for example **Box 1**.

Box 1. Harvest Control Rule for North East Arctic Cod

*The Norwegian-Russian Fisheries Commission (inter-governmental organization) manages their shared/transboundary fish stocks in the North East Arctic Ocean. Below is a translation (not official) of their Harvest Control Rule for cod (*Gadus morhua*). This example is based on a system of catch quotas but similar rules could be designed for different kinds of effort regulation systems.*

Management Rule for the North East Arctic Cod

The Parties agreed to follow a harvest strategy for cod that fulfill the objectives of:

- Securing a long-term high yield from the stocks;
- Achieving stability in the Total Allowable Catch (TAC) from year to year; and
- Achieving full utilization of information on all available stock assessments at all times.

Based on these principles, the Parties confirmed that the following decision-making rule would be used for setting the annual quota for the North East Arctic cod:

TAC is calculated as the average forecasted catch for the next three years using target level of fisheries mortality (Ftr).

The target level for fisheries mortality is calculated based on the spawning stock biomass (SSB) in the first year as follows:

- If SSB < Bpa, then Ftr = SSB/Bpa x Fmsy;
- If Bpa ≤ SSB ≤ 2 x Bpa, then Ftr = Fmsy;
- If 2 x Bpa < SSB < 3 x Bpa, then Ftr = Fmsy x (1 + 0.5 x (SSB – 2 x Bpa)/Bpa);
- If SSB ≥ 3 x Bpa, then Ftr = 1.5 x Fmsy; where Fmsy = 0.40 and Bpa = 460,000 metric tons.

If the spawning stock in the current year, previous year and each of the three coming years is more than the Bpa, the TAC shall not change by more than +/- 20% relative to the current TAC year. In this case, however, F should not fall below 0.30.

Note: Bpa is the pre-cautionary reference point for the SSB; and Fmsy is the fishing mortality consistent with achieving the MSY.

HCR can also include mechanisms to try to avoid large variations in the effort or quota that is allowed each time a new effort is decided and recommended. Large variations can be difficult for fishers to adapt to and can have negative effects on the market price. Finally, HCR should include precautionary limits that can overrule the previous rules if the fish stock decreases below a certain level, in which case, more drastic decreases in fishing effort should be applied in order to restore a stock to full productive capacity.

Effort or Quota Regulation

Some argue that in fisheries with gears that target many species, it is better to use quotas for each species that are caught in a certain gear, *i.e.* the so called single species quotas. This practice has been used in northern Europe for a long time. In bottom trawls for example, many different species are caught with separate yearly quotas. Until 2014, fishers were allowed to continue to fish until all quotas were fully utilized. This meant that species who's quotas were fished fully early in the year were overfished each year. In the 1980s, about 80 per cent of the fish species were heavily overfished and the ecosystem also changed because of the disappearing species. In an "effort regulation system" such as that applied in Thailand where the number of days at sea is limited, it is also necessary to handle all major species that are caught by setting a suitable effort level. This shows that the problem in mixed fisheries is similar whether a "single species quota system" or an "effort system" is used. There are other regulatory systems such as results-based fisheries that are much better at handling mixed fisheries, but these depend on stricter control and surveillance system. Nevertheless, with sensible HCR, situations in mixed fisheries could be reasonably handled either with effort or quota regulation.

Way Forward

Developing the design of HCR should involve all stakeholders to enhance understanding and compliance. It is often much easier to agree on the targets and rules for deciding the fishing effort before the fishing effort should be set. A harvest control rule could be implemented at all levels from local and national to regional. Most importantly, it has the dual advantages of reducing the pressure on decision makers from stakeholders and at the same time, making the target for the fisheries regulation and the decision process transparent.

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The M.V. PLALUNG I of SEAFDEC serving as Model for Thai Trawlers

Kom Silapajarn and *Sutee Rajruchithong*

When the Government of Thailand was confronted with the need to address the pressing international requirements on labor in the fisheries sector, more particularly in trawl fisheries, SEAFDEC offered its 17-GT Thai-style trawler, the M.V. PLALUNG I as a demonstration boat as it resembles that of a typical Thai trawler. The M.V. PLALUNG I was acquired by SEAFDEC in 1982 through funds provided by the Government of Thailand, and was intended to be used by the SEAFDEC Training Department (TD) during its conduct of onboard practical training on fishing technology, navigation, onboard fish handling, seamanship, marine engineering, and fishing vessel operation in general. As a demonstration fishing boat, the M.V. PLALUNG I would showcase the efforts of the Government of Thailand in providing fishers and fishing vessel crew decent working conditions onboard fishing vessels. However, such action called for the modification of the design and structures of the M.V. PLALUNG I to be able to serve as a model for Thai trawlers. Thus, the Department of Fisheries (DOF) of Thailand collaborated with SEAFDEC, the Thai Union Group, and Nestlé Thailand to pursue the three-year project (2016-2018) aimed at modifying the design and reinstalling the structures of the M.V. PLALUNG I with financial and technical support provided by the Thai Union Group and Nestlé Thailand.

Fisheries is important to the socio-economic development of Thailand, as it generates big revenues not only for the Government coffers but also to the people engaged in the fisheries sector. In 2015, the country exported fishery products with a total value of USD 5,947.3 million (DOF Fisheries Statistics, 2015 cited in Yenpoeng, 2017 (unpublished)). Also in 2015, Thailand had 10,382 registered commercial fishing vessels, of which about 9,300 were fishing in Thai waters while the rest are operating outside of the Thai waters (DOF Fisheries Statistics, 2015 cited in Yenpoeng, 2017 (unpublished)). Therefore, Thailand had been exerting efforts to be able to conform to the minimum requirements of the United Nations for work onboard fishing vessels as stipulated in the Work in Fishing Convention, 2007 or C188. Although applicable for vessels measuring 24 meters in length and over, C188 could still be applied to fishing vessels measuring below 24 meters in length if the country so desired as practical. C188 is also not compulsory for countries that have not yet ratified it, nonetheless, many countries in the Southeast Asian region have already adjusted their respective national laws to conform to the provisions in C188, such as minimum age of fishers, fisher's work agreement, number of hours of work, and so on (Kaewnuratchadasorn and Sulit, 2016). The progress of development in the Southeast Asian region with regards to the improvement of working conditions of fishery labor including recruitment and treatment of migratory labor had been discussed and summarized during the First Regional Technical Consultation (RTC) on Labor Aspects within Fishing Industry in the ASEAN Region organized by SEAFDEC in February 2016 with support from the SEAFDEC-Sweden Project (SEAFDEC, 2016).

In an effort to address labor concerns in the country's fisheries sector, concerned national agencies in Thailand with the cooperation of the private sector, developed in 2016 the Guidelines for Good Labor Practices (GLP) to comprise provisions on the existing standards based on Thai labor laws and regulations as well as those related to international labor standards. Four GLP Guidelines have been established, such as the GLP for Primary Processing Workplaces, GLP for Shrimp Farms, GLP for Seafood Factories, and GLP for Fishing Vessels. Specifically, the GLP for Fishing Vessels covers the "fundamental labor rights (*e.g.* forced and child labor, discrimination), working conditions (*e.g.* compensation, benefits and welfare, contract and human resources, workplace cooperation and communications, occupational safety and health, workplace hygiene, maternal health), and general workers' welfare among others" (Kaewnuratchadasorn and Sulit, 2016). It is under the GLP for Fishing Vessels that the Government of Thailand has pursued the need to develop a model for Thai trawlers, the design of which would be promoted throughout the country.

Work in Fishing Convention, 2007

The Work in Fishing Convention (C188), which was adopted during the 96th International Labour Conference of the International Labour Organization (ILO) in 2007 and came into force on 16 November 2017, is aimed at ensuring that "fishers have decent conditions of work onboard fishing vessels, especially in terms of the minimum requirements for work onboard, conditions of service, onboard accommodation and food, occupational safety and health protection, medical care, and social security" (ILO, 2007). Applicable to all fishers and fishing vessels engaged in commercial fishing operations, C188 also includes provisions on the "responsibilities of fishing vessel owners and skippers" (**Box 1**) with respect to the safety of the fishers on board and the safety of the vessels, minimum age for work onboard fishing vessels and assignment to certain types of activities, medical examination and certification

Box 1. Responsibilities of fishing vessel owners, skippers and fishers (ILO, 2007)

Article 8

1. The fishing vessel owner has the overall responsibility to ensure that the skipper is provided with the necessary resources and facilities to comply with the obligations of this Convention.
2. The skipper has the responsibility for the safety of the fishers on board and the safe operation of the vessel, including but not limited to the following areas:
   (a) providing such supervision as will ensure that, as far as possible, fishers perform their work in the best conditions of safety and health;
   (b) managing the fishers in a manner which respects safety and health, including prevention of fatigue;
   (c) facilitating on-board occupational safety and health awareness training; and
   (d) ensuring compliance with safety of navigation, watchkeeping and associated good seamanship standards.
3. The skipper shall not be constrained by the fishing vessel owner from taking any decision which, in the professional judgement of the skipper, is necessary for the safety of the vessel and its safe navigation and safe operation, or the safety of the fishers on board.
4. Fishers shall comply with the lawful orders of the skipper and applicable safety and health measures.

required for work on fishing vessels with the possibility of exceptions for smaller vessels or those at sea for short periods, manning and hours of rest, crew lists, fishers' work agreements, repatriation, recruitment and placement of fishers and use of private employment agencies, payment of fishers, and protection in the case of work-related sickness, injury or death (through a system for fishing vessel owners' liability or compulsory insurance, workers' compensation or other schemes)."

While Thailand has not yet ratified C188, the Government has already complied with some provisions in it. In fact in December 2014, Thailand adopted the Ministerial Regulation on Protection of Workers in the Sea Fishing Sector under the country's Labour Protection Act B.E. 2541 (1998). This development was supported through the technical cooperation between Thailand's Department of Labour Protection and Welfare of the Ministry of Labour, and the ILO Project on Tripartite Action to Protect Migrant Workers within and from the Greater Mekong Sub-region from Labour Exploitation or the ILO GMS TRIANGLE I Project (ILO, 2017).

Modification of the M.V. PALUNG I

In order to serve as model for Thai trawlers, the original design M.V. PLALUNG I with length overall (LOA) of 17.5 meters and capacity of 35 GT had to be modified. The process involved replacing the original superstructures with larger ones to be able to accommodate additional navigational equipment, such as RADAR, GPS, plotter, and echo sounder, as well as top-of-the-line communications equipment (*e.g.* single sideband (SSB) and very high frequency (VHF) radio systems). Renovations were also made including improvement of the service areas, such as the galley, sleeping quarters to accommodate individual crew members, mess room, ad toilet. Moreover, the net drum for trawl net operation was re-installed at the stern deck behind the superstructure to facilitate easy retrieving of the trawl net by minimal number of fishers. A sewage tank was also installed in the engine room to treat all wastes prior to disposal.

As agreed among the Parties involved in the Modification Project, SEAFDEC would support the conduct of training on safety at sea and energy optimization. During the first demonstration and training on 30 November-4 December 2017 organized by TD in the Eastern Gulf of Thailand, the important issues raised by the fisher-trainees related to the remodeled superstructure were subsequently addressed by

Renovation of the sleeping quarter, mess room, toilet, and galley in compliance with C188

The original M.V. PLALUNG I *(above)* and the C188-compliant remodeled M.V. PLALUNG I *(below)*

Net drum installed at the rear part to reduce the number of crew involved in fishing operations

the Parties involved in the Project to make sure that the M.V. PLALUNG I could accommodate the relevant requirements stipulated in C188 and to be able to serve as a demonstration fishing vessel and as a model for Thai trawlers.

Way Forward

The Parties involved in the Project expect that the designs of typical trawlers operating the waters of the Southeast Asian region should also be modified to ensure that the working conditions and safety at sea of fishers and fishing vessel crew members are considerably improved. Such modifications however, are not only directed to Thai trawlers but also for other trawlers in the Southeast Asian region.

While SEAFDEC had agreed to support the conduct of onboard demonstration and training for fishers and fishing vessel crew members, Verité, a global, independent and non-profit organization has also committed to support the training about the aspects of labor and human rights. During the inauguration of the remodeled M.V. PLALUNG I, the Parties expressed the desire to promote the redesigning of existing trawlers in the region to ensure that labor issues in fishing operations are addressed as well as fishing technologies are improved that would guarantee the welfare of fishers and fishing vessel crew members, and eventually comply with the requirements and provisions stipulated in C188.

References

DOF Fisheries Statistics (cited in Yenpoeng, 2017 (unpublished)). 2015. National Fisheries Statistics of Thailand (in Thai language with English translation), Department of Fisheries of Thailand, Bangkok, Thailand; 87 p

ILO, 2007. C188 - Work in Fishing Convention, 2007 (No. 188): Convention concerning work in the fishing sector. Adoption: Geneva, 96th ILC Session (14 Jun 2007), Entry into force: 16 Nov 2017. ILO, Geneva, Switzerland;

ILO, 2017. Gap Analysis of the Work in Fishing Convention, 2007 (No. 188), and Thai national laws, regulations and other measures concerning conditions of work on board fishing vessels. Doc Ver.1 Ref THA/15/03/EUR DRAFT. ILO, Bangkok, Thailand. May 2017

Kaewnuratchadasorn, P. and V. Sulit. 2016. Forging Regional Cooperation to Address Fishery Labor Issues. ***In***: Fish for the People, Volume 14 Number 2: 2016 (Special Issue). Southeast Asian Fisheries Development Center; pp 54-62

SEAFDEC. 2017. Report of the First Regional Technical Consultation (RTC) on Labor Aspects within Fishing Industry in the ASEAN Region, 25-27 February 2016, Bangkok, Thailand. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 45 p

Yenpoeng, T. 2017 (unpublished). Fisheries Country Profile: Thailand. In partial fulfillment of the Project on Fisheries Profile of Southeast Asia by the 2017 Members of the Regional Fisheries Policy Network (RFPN). Southeast Asian Fisheries Development Center, Bangkok, Thailand; 13 p

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CALENDAR OF EVENTS

Date	Venue	Title	Organizer(s)
		2018	
2-5 April	Brunei Darussalam	3rd On-site Training and Kick-off Pilot Testing for eACDS	SEAFDEC Secretariat
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	SEAFDEC/AQD
9-13 April	Nadi, Fiji	34th FAO Regional Conference for Asia and the Pacific	FAO/RAP
10 April	Samut Prakan, Thailand	Technical Meeting on Sharks and Rays Data Collection Planning 2018-2019	SEAFDEC/TD
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
18-20 April	London, UK	CITES International Technical Workshop on Eels (*Anguilla* spp.)	CITES
24-26 April	Bangkok, Thailand	Regional Technical Meeting on Fisheries Resources Enhancement in Southeast Asia	SEAFDEC/TD
7-8 May	Bangkok, Thailand	10th Meeting of the ASEAN Fisheries Consultative Forum (AFCF)	ASEAN
7-9 May	Malaysia	Workshop for Preparation of Terminal Report for the IDB Project and Proposal for the New JAIF Project	SEAFDEC/ MFRDMD
9-12 May	Bangkok, Thailand	26th Meeting of the ASEAN Sectoral Working Group on Fisheries (ASWGFi)	ASEAN
9-25 May	Iloilo, Philippines	Training Course on Abalone Hatchery and Grow-out	SEAFDEC/AQD
11-13 May	Cebu, Philippines	35th Session of Asia-Pacific Fishery Commission (APFIC)	APFIC
14-18 May	Surat Thani, Thailand	Training Course on Sustainable Fisheries Management through Ecosystem Approach	SEAFDEC/TD
14-18 May	Rizal, Philippines	Training Course on Freshwater Prawn Hatchery and Grow-out Operations	SEAFDEC/AQD
17 May	Bangkok, Thailand	Workshop on Regional Database on Alternative Feed Ingredients in Aquaculture	SEAFDEC/AQD
7-8 June	Bangkok, Thailand	International Technical Workshop on Tropical Anguillid Eels in Southeast Asia	SEAFDEC Secretariat
12-13 June	Danang, Viet Nam	Bilateral Technical Meeting Between Thailand and Viet Nam	SEAFDEC Secretariat
18-22 June	Rizal, Philippines	Training Course on Tilapia Hatchery and Grow-out Operations	SEAFDEC/AQD
19 Jun-25 Jul	Iloilo, Philippines	Training Course on Marine Fish Hatchery	SEAFDEC/AQD
20-22 June	Bangkok, Thailand	Regional Technical Consultation on International Fisheries-related Issues	SEAFDEC Secretariat
26-28 June	Maldives	29th Governing Council Meeting of the Network of Aquaculture Centres in Asia Pacific (NACA)	NACA
9-13 July	Rome, Italy	33rd Session of the Committee on Fisheries (COFI)	FAO
16-21 July	Geneva, Switzerland	Animal Committee Meeting of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	CITES
13-17 August	Rizal, Philippines	Training Course on Tilapia Hatchery and Grow-out Operations	SEAFDEC/AQD
13 Aug-3 Sep	Iloilo, Philippines	Training Course on Mangrove Crab Hatchery and Nursery Operations	SEAFDEC/AQD
20-24 August	Iloilo, Philippines	Training Course on Catfish Hatchery and Grow-out Operations	SEAFDEC/AQD
10-14 September	Rizal, Philippines	Training Course on Freshwater Prawn Hatchery and Grow-out Operations	SEAFDEC/AQD
17-26 September	Iloilo, Philippines	Training Course on Mangrove Crab Nursery 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
22-26 October	Rizal, Philippines	Training Course on Catfish Hatchery and Grow-out Operations	SEAFDEC/AQD
22-26 October	Chiang Mai, Thailand	3rd World Small-Scale Fisheries Congress	TBTI
29-30 October	Bali, Indonesia	Our Ocean Conference 2018	MMAF, Indonesia

Southeast Asian Fisheries Development Center (SEAFDEC)

What is SEAFDEC?

SEAFDEC is an autonomous intergovernmental body established as a regional treaty organization in 1967 to promote sustainable fisheries development in Southeast Asia. SEAFDEC currently comprises 11 Member Countries: Brunei Darussalam, Cambodia, Indonesia, Japan, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam.

Vision

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

Mission

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

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


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The second prize drawing winner, *Deborah Ong*, from the national drawing contest in Singapore

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.