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 at 49:

Strengthening the foundations for sustainable fisheries in Southeast Asia

Southeast Asian Fisheries Development Center

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Editorial

Having been established in 1967, SEAFDEC in 2016 would be almost at the end of its 5-decade cycle of promoting sustainable fisheries development in Southeast Asia. The year 2016 is therefore an occasion for SEAFDEC to look at its achievements and successes, and take lessons from its experiences for future advantages. This is also the time to finish off what has been left undone before getting into the threshold of its golden jubilee, when the new door of opportunity would open for SEAFDEC as its 5-decade cycle door closes. The three issues for Volume 14 of the Special Publication *Fish for the People* would therefore support the efforts of SEAFDEC in reviewing its achievements and examining the lessons learned from past programs and activities.

Experiences of the Member Countries on sustainable development of fisheries and aquaculture would therefore be reflected in the issues of Volume 14 for SEAFDEC to muster the lessons and experiences that could be referred to while developing future plans and programs. Through the Technical Departments of SEAFDEC, programs had been conducted in the region during the five decades of its existence. These programs cover wide disciplines of fisheries, from marine and inland capture fisheries to aquaculture, post-harvest practices and trade. Implementation of these activities had been yoked together with conservation and management of fishery resources to ensure the sustainable utilization of such resources.

While recognizing the fact that undertaking responsible fisheries is crucial in ensuring the sustainability of fisheries in Southeast Asia, SEAFDEC in cooperation with the Member Countries regionalized the global Code of Conduct for Responsible Fisheries adopted by FAO in 1995, and came up with a series of Regional Guidelines for Responsible

Fisheries in Southeast Asia. Addressing the specificities of fisheries in Southeast Asian, these Regional Guidelines facilitated the development of most practical national measures and legal systems on various aspects of fisheries leading to improvements in the respective countries' fisheries management based on responsible approach. Moreover, considering that fisheries of the Southeast Asian region comprise large numbers of small-scale fishers, appropriate management concepts such as community-based fisheries management, rights-based fisheries, and the Ecosystem Approach to Fisheries Management, among others, have been promoted by SEAFDEC to facilitate their adoption by the Southeast Asian countries. Activities on improvement of fisheries data collection and compilation of fishery statistics from countries in the region have also been carried out, while utilization of such data as basis for science-based policy planning and management has also been promoted.

SEAFDEC has also been providing platforms to support the development of fisheries policy frameworks in close cooperation with the Member Countries under the auspices of the ASEAN-SEAFDEC Strategic Partnership. Based on the Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region adopted in 2001 and its subsequent updated version adopted in 2011, several regional management frameworks and guidelines have been developed and implemented aiming towards enhancing the sustainable utilization of fishery resources; combating Illegal, Unreported, and Unregulated or IUU fishing; managing fishing capacity; and building up the traceability of fish and fishery products from the region. The activities of SEAFDEC have therefore been appropriately and efficiently planned, developed and promoted with the ultimate goal of strengthening the foundations for sustainable fisheries development in the Southeast Asian region.

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CONTENTS

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.

Recording Sharks and Rays Statistics from Southeast Asia at Species Level

Worawit Wanchana, Ahmad Ali, and *Santiphong Putsa*

The Southeast Asian region, which includes Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Thailand, and Viet Nam, is home to a rich diversity of sharks, rays, skates, and chimaeras (Class Chondrichthyes). According to Ahmad and Lim (2012), Ahmad *et al*. (2013) and Ahmad *et al*. (2014), at least 329 species of chondrichthyans are found to inhabit in this region from freshwater to the deep sea. This includes 174 species of sharks from 8 orders (29 families), 148 species of rays from 5 orders (19 families), and 7 species of chimaeras from two families. Ahmad *et al*. (2013) reported that Indonesia recorded the highest diversity of sharks with 114 species and 26 families followed by Philippines (94 species; 26 families), Thailand (64 species; 19 families), Malaysia (63 species; 18 families), Brunei Darussalam (34 species; 13 families); Myanmar (34 species; 10 families), Viet Nam (29 species; 13 families), and Cambodia with 11 species and 6 families. As for batoids (rays and skates), Ahmad *et al*. (2014) reported that Indonesia also recorded the highest number with 106 species and 17 families followed by Malaysia (84 species; 14 families), Philippines (66 species; 18 families), Thailand (71 species; 12 families), Cambodia (55 species; 14 families), Myanmar (44 species; 10 families), Viet Nam (38 species; 12 families), Brunei Darussalam (36 species;11 families), and Lao PDR with 3 species and one family. Information on chimaeras however is still scanty. Until 2015, only 4 species of Hydrolagus, 2 species of Chimaera and one species of Harriotta have been recognized. Indonesia recorded 4 species of Chimaerids while the Philippines recorded 3, and Malaysia and Thailand recorded only one species. With new species continuously being discovered, the number of Chondrichthyan species in this region is expected to increase.

International Concern on Sharks Conservation and Management

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) promotes the conservation and protection of species of wild animals and plants considered endangered to ensure that their international trade does not threaten the survival of the species in the wild. CITES has been protecting large numbers of species of animals and plants against over-exploitation through international trade by listing these in the CITES Appendices. Once species are listed in Appendix I, II or III of CITES, depending on the level of endangerment, the member countries of CITES are obliged to take the required actions with respect to international trade. Deterioration of the global environment leads to the listing of a number of species including some fishery resources in the CITES Appendices which had continually increased throughout the past decades.

Being considered as among the endangered species, several species of sharks and rays have been proposed for listing in the CITES Appendices for protection and conservation (SEAFDEC, 2012). CITES has played a pivotal role in the collection of biological data and trade information on sharks. The term "sharks" is taken to include all species of sharks, skates, rays, and chimaeras (Class Chondrichthyes). More specifically, Resolution Conf. 9.17 adopted in November 1994 urged the Parties to submit to the CITES Secretariat available information concerning trade and status of sharks. As a result, the Food and Agriculture Organization of the United Nations (FAO) and other international fisheries management organizations have established several programs to collect biological and trade data on species of sharks. At the 10th Conference of the Parties of CITES (CoP10 CITES), focus was given on the need to improve the methods of identifying, recording, and reporting landings of sharks by species. Since then, the importance of compiling statistics on sharks and rays had been addressed by many organizations including SEAFDEC (Chamsai and Siriraksophon, 2011). During the 16th Conference of Parties of CITES (CoP16 CITES) in 2013, five species of sharks and all manta rays were listed in Appendix II, namely: oceanic whitetip shark (*Carcharhinus longimanus*); porbeagle shark (*Lamna nasus*); scalloped hammerhead shark (*Sphyrna lewini*); smooth hammerhead shark (*Sphyrna zygaena*); great hammerhead shark (*Sphyrna mokarran*), giant manta (*Manta birostris*), Alfredi manta ray (*Manta alfredi*), and *Manta* sp. These species were added to the list of other sharks and sawfishes that had already been listed in the CITES Appendices over the past decades. The complete list of shark species in the CITES Appendices could be gleaned at: *https://cites.org/eng/prog/shark/other_sharks.php*.

Meanwhile, FAO promoted the International Plan of Action for Conservation and Management of Sharks (IPOA-Sharks) which was adopted during the Meeting of FAO Committee on Fisheries (COFI) in 1999, to provide support for the implementation of the Code of Conduct for Responsible Fisheries, especially on the conservation and management of sharks and their long-term sustainable use. The IPOA-Sharks covers all sharks and other chondrichthyan fisheries, both target and non-target fisheries, whether they be industrial,

artisanal or traditional fisheries. Class Chondrichthyes includes the cartilaginous fish species that are jawed vertebrates with paired fins, paired nares, scales, a heart with its chambers in series, and skeletons made of cartilage rather than bone (*https://en.wikipedia.org/wiki/Chondrichthyes*). The IPOA-Sharks also intends to provide a framework for the development of national, sub-regional, and regional plans as well as assessments of sharks in member countries' respective waters and also for trans-boundary species of sharks.

SEAFDEC Initiatives to Improve Compilation of Sharks and Rays Statistics

In the Southeast Asian scenario, the pressure to list several commercially captured shark and ray species in the CITES Appendices has recently been rising and SEAFDEC was asked by its Member Countries to address such concern. Through a series of consultations and meetings, the SEAFDEC Member Countries agreed to collect data on various species of sharks and rays, and develop their respective management plans as necessary. Specifically, the assistance of SEAFDEC was sought by its Member Countries for the identification of elasmobranchs species which is a fundamental step in data collection and law enforcement, especially in terms of conservation and protection of the economically-important species of sharks and rays. Thus, attempts had been made by SEAFDEC to assist the ASEAN Member States (AMSs) in improving their system of compiling the statistics of sharks and rays (Chamsai *et al*., 2013). Nonetheless, there is still a need to strengthen the expertise of the AMSs in identification and compilation of biological data on sharks and rays. In addition, information on utilization of by-catch sharks and rays should also be collected and compiled to enhance the understanding of stakeholders in the AMSs on the importance of sharks and rays, and on the need to establish fisheries management measures for such economically-important species.

Box 1. Initiatives of SEAFDEC to improve sharks conservation and management in the Southeast Asian region

- Providing a platform at regional level to:
  - Update and share progress of work on development/implementation of IPOA and NPOA-Sharks among ASEAN Member States (AMSs), *continuing*
  - Develop common understanding of the AMSs on the issues related to CITES listing of sharks and rays, *continuing*
- Providing regional technical assistance for AMSs to come up with stock assessment of sharks and rays in their respective countries, including:
  - Dissemination of the publication on Field Guide Book for Sharks and Rays Species Identification, *completed*
  - Development of Standard Operating Procedures (SOPs) for sharks/rays data collection for the Southeast Asian region, including analysis and reporting systems, *completed*
  - Regional analysis of sharks and rays data collected at selected landing sites in seven (7) countries, *ongoing*
- Providing assistance in terms of capacity building programs on elasmobranch taxonomy, at regional and national levels, through:
  - Regional Training of Trainers on Elasmobranch Taxonomy, *continuing*
  - National Workshops on Sharks and Rays Data Collection, *first sessions completed; subsequent sessions planned*
  - On-site Training on Elasmobranch Taxonomy and Biology in selected member countries, *ongoing*

National workshop conducted by SEAFDEC in Indonesia in 2015 to identify sharks and rays species

In Southeast Asia, sharks and other elasmobranchs are utilized as non-target catch by hook-and-line, long-line, gillnet, trawl net, purse seine net, and other fishing gears. Even though the Southeast Asian waters have one of the richest elasmobranch diversity in the world, the status of these resources and their utilization are still largely undetermined due to insufficient data on catch, landings at species level, and trade as well as limited information on the biological parameters of many sharks species due to limited capacity in collecting fishery data in most countries in the region. This leads to difficulties in assessing the status of sharks stocks and in planning and implementing management measures for sharks. Therefore, SEAFDEC has initiated some regional actions to improve sharks conservation/management in Southeast Asia as shown in **Box 1**.

Pilot Study on Recording of Sharks and Rays Fisheries in Southeast Asia

SEAFDEC carried out its first regional studies on recording of sharks and rays landings at species level in Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Thailand, and Viet Nam during 2003-2004. Studies on local use, marketing and international trade were also carried out in Malaysia, Singapore, and Thailand with technical and financial support from SEAFDEC. Results of these one-year studies included: quantity of sharks catch and its proportion to total fish catch; total weight composition of fishing gear catching sharks; catch composition and biology of dominant species captured; other biological aspects; and shark utilization and marketing. Nevertheless, in the process of carrying out such studies, the countries encountered various constraints, as shown in **Box 2**.

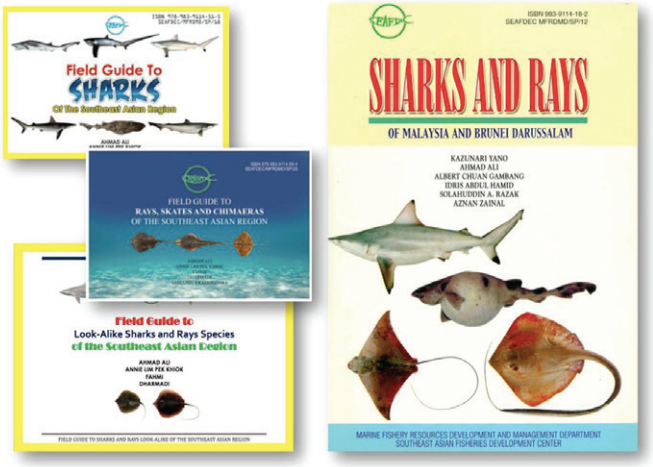
Sites surveyed by SEAFDEC during the one year study on sharks and rays landings in 2003-2004

Box 2. Constraints encountered by participating AMSs during survey on local use and marketing of sharks and rays

- Insufficient knowledge and experience in data collection, particularly in conducting biological research including taxonomy and in determining the maturity of sharks
- Limited financial support hindering optimal data collection
- Inadequate cooperation of boat owners, fishers and landing site owners during data collection and biodiversity study
- Access to samples of large-size sharks almost nil as these are already cut into smaller parts due to limited fish hold capacity of fishing vessels, or landing headless, or already gutted or dried

Publication of Book and Field Guides to Identify Sharks and Rays up to Species Level

In order to address the needs of the AMSs in improving their national statistics in recording landings of sharks and rays up to species level, the SEAFDEC Marine Fishery Resources Development and Management Department (SEAFDEC/MFRDMD) published a series of books on elasmobranch taxonomy since 2006. To date, four (4) publications have



already been produced, disseminated and used as regional references for sharks and rays species identification.

Technical Assistance to AMSs on Sharks Conservation and Management

During the various regional fora organized by SEAFDEC to discuss the status of sharks and rays in the Southeast Asian region, SEAFDEC encouraged all AMSs to develop their respective National Plans of Action on Sharks (NPOA-Sharks) to be able to develop management measures for sharks and rays. At the outset, during the first SEAFDEC regional technical meeting on sharks which was held back-to-back in 2003 with the meeting of the ASEAN Sectoral Working Group on Fisheries, policy support was obtained for the promotion of regional initiatives on sharks. In 2008, SEAFDEC in collaboration with the AMSs started the compilation of fisheries statistics based on the adopted Regional Framework for Fisheries Statistics in Southeast Asia (SEAFDEC, 2008) that encourages recording of data on sharks and rays to species level. However, most of AMSs still could not report their catch landings of sharks and rays by species due to limited capacity on taxonomy of elasmobranch and inadequate experience for carrying out surveys on data collection of sharks and rays landings.

Thus, with financial support from the Government of Japan under the Fisheries Consultative Group Mechanism of the ASEAN-SEAFDEC Strategic Partnership (FCG/ASSP), SEAFDEC organized a series of technical meetings since 2011 for the AMSs to update on their progress of implementing the

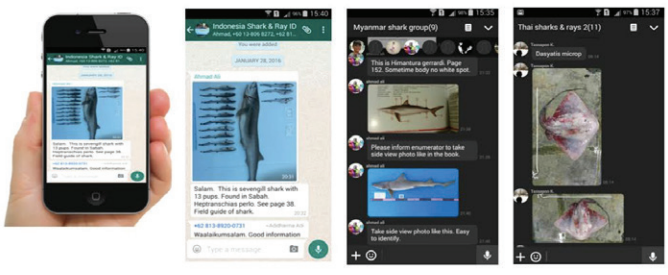
IPOA-Sharks and developing their respective NPOA-Sharks. During such technical meetings, clarifications on the technical assistance required by the AMSs in improving data collection of sharks and rays at landing sites had been highlighted.

Regional Activities to Record Sharks and Rays Landings, Utilization, Marketing and Trade

With financial support from the Government of Japan (through the SEAFDEC Secretariat and MFRDMD) and the European Union (EU) through the CITES Secretariat, SEAFDEC has carried out since 2015 a one-year regional project on sharks and rays data collection in seven (7) countries of the ASEAN, namely: Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Thailand, and Viet Nam (**Table 1**). The project is aimed at compiling information for the preparation of Standard Operating Procedures (SOPs-Sharks) on data collection, and undertaking activities that include national workshops and training sessions on sharks and rays identification for enumerators, recording of landing data at species level, and validation of data; mid-term evaluation meeting; and final meeting to review the national and regional reports. Data collection at selected landing sites which started in July 2015 would be completed during the third quarter of 2016. All information are collected based on the SOPs-Sharks to ensure that recording and analysis are standardized at the regional level.

Table 1. Selected pilot landing sites by sub-regional waters

Country	No. of survey sites	Selected pilot landing sites
Cambodia	1	Preah Sihanouk
Indonesia	2	Aceh, Cilacap
Malaysia	6	Perak, Sarawak, Sabah
Myanmar	2	Mawlamyine, Yangon
Philippines	2	Palawan, Luzon
Thailand	2	Songkhla, Ranong
Viet Nam	2	Vung Tau, Binh Thuan



Through this SEAFDEC/EU-CITES Sharks Project, the major outputs could include the following:

- Translated two (2) field guides on sharks and rays species identification in Viet Namese and Cambodian languages for dissemination to respective countries
- Compiled and published results from one-year data collection in project's participating countries (total catch and landing of sharks/rays at selected landing sites; new record of sharks/rays species in the participating countries, etc.) for dissemination to the Southeast Asian region
- Information on weight of sharks/rays by species landed in selected landing sites
- Taxonomic information of sharks and rays caught in the Southeast Asian region
- Trained enumerators making correct and valid identification of species at landing sites during data collection activities
- Compiled information and utilization of sharks and rays in the AMSs

Moreover, the Regional Network on Sharks was established through a collaborative arrangement between SEAFDEC and the National Technical Coordinators (NTCs) designated by the participating countries for the SEAFDEC/EU-CITES Sharks Project. The NTCs play a very important role in implementing the one-year data collection activities in collaboration with their respective local enumerators for collecting the necessary data at selected landing sites.

National workshops were then organized from July to September 2015 at selected landing sites proposed by respective participating countries. Participated by the NTCs of respective countries, local enumerators, and observers, the workshops considered the proposed activities and work plan presented by the SEAFDEC Project Team as well as the SOPs-Sharks and steps for the data key-in. Photograph-taking techniques for scientific data collection were also practiced. All national workshops were followed by visits to designated pilot landing sites to test the various applications and techniques in data collection.

Furthermore, the National Sharks Group (NSG) established in each participating country had been encouraged to use smart mobile telephone application such as Whatsapp and LINE. Members of the NSG include regional shark experts and resource persons from SEAFDEC, NTCs of respective countries, and local enumerators. The use of Whatsapp and LINE applications is considered useful for data validation and confirmation of unidentified species. After the workshops, compilation of data collected at selected landing sites has

been pursued. As agreed during such workshops, all data collected must be submitted to the regional experts through the NTCs of respective countries within two (2) weeks of the following month.

Way Forward

In order to enhance the understanding of stakeholders on the importance of sharks and rays in the Southeast Asian region and the need to establish fisheries management measures, information on utilization of by-catch sharks and rays would also be compiled. MFRDMD has already started to collect socio-economic information on by-catch sharks and rays in the participating countries by taking advantage of the opportunities during the abovementioned national training activities conducted on-site. During this one-year project implementation, the capacity of AMSs to report their national statistics for sharks and rays up to species level could be enhanced. As a result, national activities in recording sharks and rays landing by local enumerators could be expanded to cover the whole countries participating in the project. Finally, data from AMSs on sharks and rays landing up to species level could be included in the compilation of data for the Fishery Statistical Bulletin of Southeast Asia (SEAFDEC, 2015) which is being produced by SEAFDEC annually.

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Purse Seine Fisheries in Southeast Asian Countries: A Regional Synthesis

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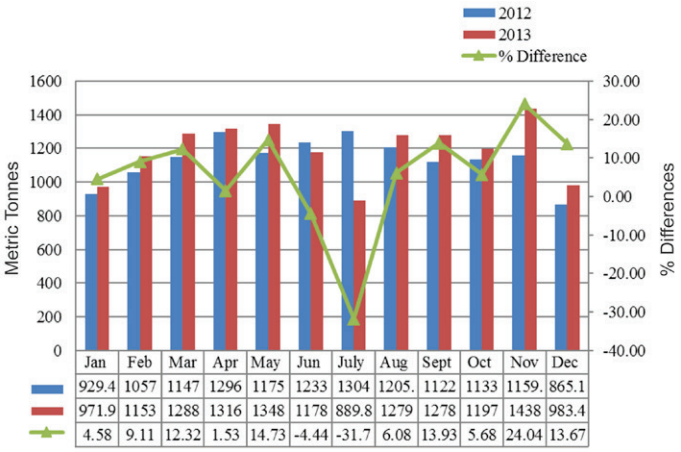
Several Southeast Asian countries, namely: Brunei Darussalam, Cambodia, Indonesia, Malaysia, Myanmar, Thailand, Philippines, and Viet Nam surround the South China Sea (SCS) which is one of the most important fishing areas for these coastal states, and where some of its fishery resources form shared stocks among these bordering countries. SCS encompasses a portion of the Pacific Ocean stretching roughly from Singapore and the Strait of Malacca in the Southwest, to the Strait of Taiwan (between Taiwan and China) in the northeast. The hydrography of SCS consists of continental shelf of 200 meters deep, continental slopes and deep waters down to more than 2,000 meters. In the SCS, small pelagic fisheries dominate by about 20% of the total marine capture fisheries. Living in the surface and mid-water column of ocean or inland ecosystem, pelagic fishes range in size from small coastal foraging fishes, such as herrings and sardines, to large apex predator oceanic fishes, such as the Southern Bluefin tuna and oceanic sharks. These pelagic fishes are usually agile swimmers with streamlined bodies, and capable of sustained cruising on long distance migrations. In many countries surrounding the SCS, purse seine has been commonly used to capture these pelagic fishes. The status of purse seine fisheries in the countries bordering the SCS is summarized in this article based on the information provided by the concerned countries and compiled by the SEAFDEC Marine Fishery Resources Development and Management Department (SEAFDEC/MFRDMD) during the Core Experts Meeting for Comparative Study on Purse Seine Fishery in the Southeast Asian Region organized by SEAFDEC/MFRDMD in Kuala Lumpur, Malaysia on 26-28 August 2014. The same information had also been reflected in a subsequent publication entitled "Current Status of Purse Seine Fisheries in the Southeast Asian Region" (SEAFDEC/MFRDMD, 2015). It should be noted that the term "South China Sea" is used in its geographical sense and does not imply recognition of any territorial claims within the area. A way forward to bring in long-term sustainable purse seine fisheries in Southeast Asia, more particularly in the SCS and Andaman Sea, is also being highlighted.

Based on FAO definition, purse seine is "made of a long wall of netting framed with floatline and leadline (usually, of equal or longer length than the former) and having purse rings hanging from the lower edge of the gear, through which runs a purse line made from steel wire or rope which allow the pursing of the net." FAO also claimed that "for most of the situation, purse seine is the most efficient gear for catching large and small pelagic species that is shoaling." In Southeast Asia, purse seines had been used since the nineteenth century, to catch pelagic fishes as alternative to trawl fishing targeting demersal fish stocks that had been declining. Earlier, the fisheries make use of various surrounding nets that had been modified into purse seines, and later, the use of commercial purse seines had been picked up by many countries in the region.

Discussed in the article is the development and status of purse seine fisheries in Southeast Asian countries that surround the South China Sea (SCS). Moreover, a way forward for long-term sustainable purse seine fisheries management in the South China Sea and Andaman Sea is also outlined based on the five-year project being carried out by the Marine Fishery Resources Development and Management Department (MFRDMD) of the Southeast Asian Fisheries Development Center (SEAFDEC). At the outset, it is crucial to take a look at the status of marine capture fisheries, especially purse seine fisheries in eight Southeast Asian countries that border the SCS area, namely: Brunei Darussalam, Cambodia, Indonesia, Malaysia, Myanmar, Thailand, Philippines, and Viet Nam.

Brunei Darussalam

Located in the northwestern part of Borneo, Brunei Darussalam has a land area of 5,765 km^2 with 161 km long coastline fronting the South China Sea. Its total marine territorial area is about 41,188 km^2 covering the so-called Brunei Fisheries Limits with potential yield of about 21,300 metric tons (MT). Contributing more than 70% to the country's total fish production, capture fisheries had been identified as one of the most important industries for the diversification of its economy. The overall performance (in terms of production and values) in 2012 and 2013 of the country's major commercial



	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
2012	929.4	1057	1147	1296	1175	1233	1304	1205.	1122	1133	1159.	865.1
2013	971.9	1153	1288	1316	1348	1178	889.8	1279	1278	1197	1438	983.4
% Difference	4.58	9.11	12.32	1.53	14.73	-4.44	-31.7	6.08	13.93	5.68	24.04	13.67

Fig. 1. Production from marine capture fisheries of Brunei Darussalam in 2012-2013

Fig. 2. Various types of purse seine vessels used in Brunei Darussalam waters

fishing vessels, namely trawlers, longlines and purse seiners are shown in **Fig. 1**.

The total production of Brunei Darussalam from marine capture fisheries had increased from 13,626 MT in 2012 to 14,320 MT in 2013 using small-scale and commercial fishing vessels, with the number of vessels increasing from 28 to 30, respectively. However, the main contributor of about 80% to the country's total marine capture fisheries production is the small-scale fisheries.

Small pelagic fishes comprise one of the most important components of the fishery resources of Brunei Darussalam. Among the commercial vessels, the major fishing gears being used to catch small pelagic fishes include purse seine and ring net, while gill net and drift net are used by small-scale fishers. Purse seine fishing in Brunei Darussalam started in 1985 with seven (7) licensed vessels. The areas where purse seine fishing and where specific fishing gears as well as engine capacities could operate, are specified by zones. Fish purse seine and tuna purse seine are the two types of purse seines operating in Brunei Darussalam waters. Fish purse seine was introduced in 1985 with only one licensed vessel, but no proper data recording of catch was made in the past. Fish purse seine was improved in early 1990s with the use of luring lights in fishing operations. Tuna purse seine started only in 2013 with two licensed vessels. The Department of Fisheries of Brunei Darussalam started providing incentives to fishers in the early 2000s to encourage them to record the necessary information during fishing operations. As a result, relevant fisheries data had already been compiled starting in 2001.

Commercial purse seiners in Brunei Darussalam (**Fig. 2**) operate on daily basis due to the size limitation of fish holds onboard and the high demand for good quality of fish landed. Commercial purse seine fisheries make use of fish aggregating devices (FADs) and lights as fishing aids to catch small pelagic fishes. Reports indicated that most of the country's purse seine vessels are made of wood and constructed in foreign countries, *i.e.* Malaysia, Viet Nam and Taiwan.

Cambodia

Covering an area of 181,035 km^2 including land and water, Cambodia has a coastline of 435 km which stretches between its borders with Viet Nam in the south to Thailand in the west. Four provinces of the country are located along this coastline, namely: Koh Kong covering a coastal length of 237 km, Sihanoukville with 105 km coastline, Kampot with 67 km, and Kep with 26 km. As reported, 525 species of marine fishes, 20 species of marine crabs, 42 species of marine gastropods, 24 species of marine bivalves, and 11 species of marine mammals, are found in the country's oceanic waters. The Kingdom of Cambodia has its Exclusive Economic Zone (EEZ) that extends from the shoreline to 200 nautical miles and covers an area of 55,600 km^2.

Cambodia is endowed with inland and marine fishery resources that play very important role in the economy and food security of the country. The fisheries sector provides employment and economic benefits to a large number of people who are involved in fishing and its ancillary activities. Due to the physical characteristics of the country's EEZ,

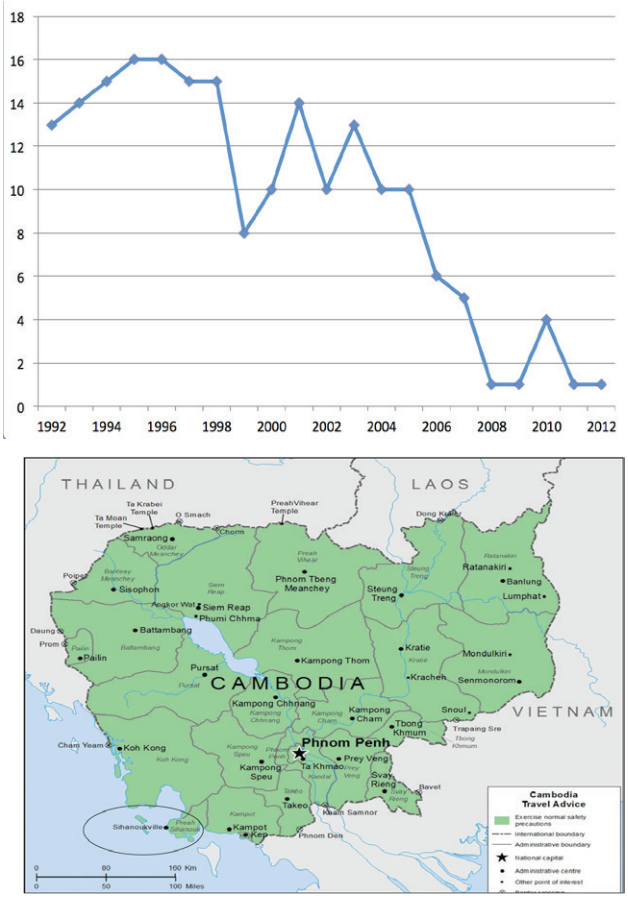


Fig. 3. Total number of purse seine vessels (*top*) recorded in Sihanoukville, Cambodia (*above*)

marine fisheries in Cambodia are mostly pelagic and their productivity contributes about 20% to the national fish production annually. Its marine fisheries could be classified by types of fishing gears, namely: small-scale, middle-scale and large-scale fishing gears operating mostly through foreign fishing ventures. Local vessels use variety of fishing gears including trawl nets, drag nets, purse seines, anchovy purse seines, gill nets, hooks and lines, and traps. In recent years, majority of coastal fishing vessels have been motorized, as a result, non-motorized vessels had reduced drastically from 3,312 in 1996 to 227 in 1999. Production of the country's marine capture fisheries had increased from 75,000 MT in 2009 to 110,000 MT in 2013 (SEAFDEC, 2015). However, it should be noted that most of the catch derived from Cambodian waters might not have been recorded in the country's national statistics considering that being harvested by foreign fishing vessels, the catch could have been shipped directly to the vessels' flag states, *e.g.* Thailand, Viet Nam.

Modern fishing technologies introduced to Cambodia sometime around the 1950s, comprise the bottom trawl and purse seine. Currently, purse seine, gill nets and long lines are the major fishing gears used by the country's coastal fishers since the early stage of fishing technology development. Generally, small-scale fishers operate from 1.0 to 45.0 km from the shoreline with water depths of 4.0 to 30.0 meters. The national fisheries statistics indicated that only one purse seine was registered in 2012 in Sihanoukville (**Fig. 3**). The number of purse seine vessels had decreased as a result of over-exploitation of targeted species due to increased use of pair trawls and light luring purse seines in the country's offshore waters. These gear types are commonly used at night, while most purse seine vessels use other fishing gear such as trawl or gill nets.

Fig. 4. Purse seine fisheries operating in Silhanoukville waters: regular fishing vessels (*top*) and long-tail vessels (*above*)

In the waters of Sihanoukville, purse seine vessels are mostly operated in the same inshore areas (**Fig. 4**). However, purse seine vessels from Kampot Province rarely operate in Kampot waters but mostly operate in Sihanoukville waters instead. Usually, one fishing operation trip of a purse seine takes about 2 to 5 days. Most purse seines operate about 5-6 trips per month.

Indonesia

Indonesia is one of the tropical countries with vast marine waters, accessing to a maritime area of 5.8 million km^2 and 3.1 million km^2 of EEZ. For fisheries management purposes, the Indonesian waters are divided into 11 fisheries management zones (**Fig. 5**) by virtue of Ministerial Decree No. PER.1/MEN/2009. Its marine fisheries mostly relate to the characteristics of the continental shelf. In general, there are three types of shelves in Indonesia's marine waters: the shallow waters (<200 m) of Sunda shelf (Java, Natuna Seas and Malacca Strait) in the western part, Sahul shelf (Arafura and Aru Seas) in the eastern part, and the deep-sea waters in between.

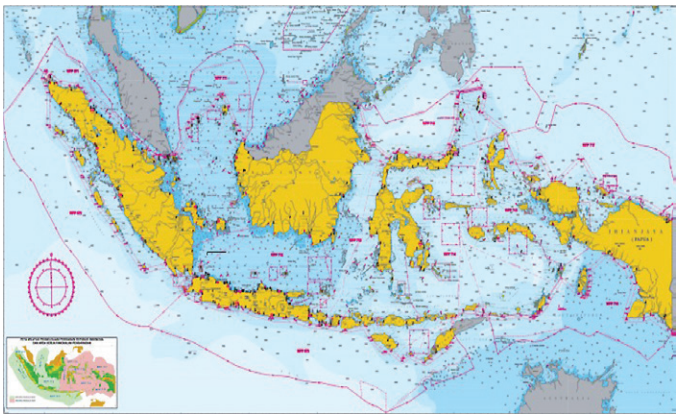


Fig. 5. Fisheries management zones of Indonesia

The characteristics of the shelves influence the fishing activities in Indonesia's waters and indicated by the use of different fishing gears. The country's capture fisheries statistics showed that its marine fish production in 2013 was about 5.7 million MT. Small pelagic species dominate the national annual landings with an estimated volume of 31% of the total fish production. In 2007, the total number of fishers at 2.2 million was mostly involved in small-scale fisheries. Purse seine fishery in the north coast of Java Sea is one of the most productive fisheries in Indonesia. Development of the country's purse seine fishery began in Central Java using large and medium purse seines (GT> 30 tons). From 1973 to

1983, pelagic fishing was only done in Java Sea but later this expanded from the west into the South China Sea (around Natuna Island, Tarempa, Pejantan) and in the shallow waters of western Makassar Strait (approximately in Lumu-Lumu, Samber Gelap, Lari-larian). However, expansion of the Javanese purse seine fishing grounds reached its maximum in 1995. Thus, most of the existing purse seiners previously operating in Java Sea changed their target species from small pelagic fishes to small tuna and tuna-like species, and among the various kinds of fishing gears, gill net and longline are used in fishing operations. The number of purse seine vessels operating in Java Sea of about 28,000 units, contributes about 2.6% to the total number of fishing vessels used in Indonesian waters.

Malaysia

The fishing areas of Malaysia are divided into several sub-regions, namely: the West Coast and East Coast of Peninsular Malaysia, and Sabah and Sarawak. Located on the West Coast of Peninsular Malaysia, Malacca Strait embraces the north Andaman Sea and the Indian Ocean, and bordered by the State of Perlis which is the country's main landing site for neritic tunas followed by Kedah, Penang, Perak and Selangor. The East Coast of Peninsular Malaysia faces the South China Sea and the country's EEZ in the SCS consists of continental shelf of 200 m deep, continental slopes and the deeper waters down to more than 2,000 m. This EEZ which extends 200 nm offshore is covered mostly by the continental shelf except the areas on the north of Sarawak and Sabah. For Sabah, the continental shelf areas only extend as narrow as 12 nm from the shoreline. The total EEZ area or continental shelf in the East Coast of Peninsular Malaysia is about 115,217 km^2 (**Fig. 6**). Vitally important to Malaysia, its fisheries sector contributes to the national economy in terms of income, foreign exchange and employment, as well as ensuring protein and food supply for the future generation. In 2012, the country's total marine landings increased by 7% from 1,373,105 MT in 2011 to 1,472,240 MT. Meanwhile, inshore fisheries contributed 64% and 60% in terms of quantity and value, respectively to the national food fish sector while deep-sea fisheries contributed only 19% and 16%, respectively. Pelagic fishes contributed about 38% (562,732 MT) of the country's total marine production and the rest

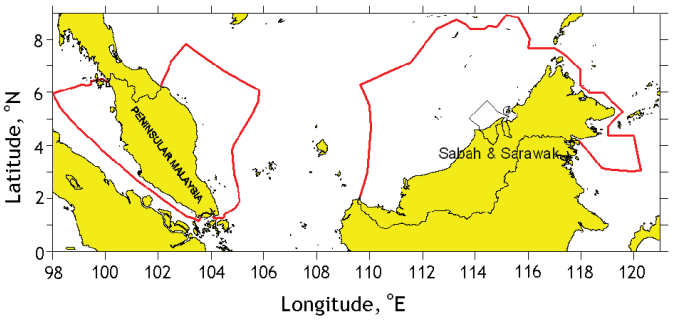


Fig. 6. EEZ boundaries of Malaysia

was contributed by demersal fishes, mollusks, crustaceans, and others. Landings from purse seine vessels recorded an increase of 7% in the East Coast of Peninsular Malaysia from 110,565 MT in 2011 to 118,698 MT in 2012.

Four major fishing activities in Malaysia are defined according to the fishing techniques adopted, namely: fish trawl, shrimp trawl, fish purse-seine, and anchovy purse-seine fishery. Fish purse seine is the main fishing gear used in catching pelagic fishes in Peninsular Malaysia, Sabah and Sarawak. Purse seines are the second most efficient fishing gears that contribute to the country's total fish landings after trawlers. **Table 1** shows the number of purse seine vessels which had significantly reduced from 1,280 units in 2012 to 1,238 units in 2013. The country's purse seine vessels have been categorized based on their gross tonnage (GRT), *i.e.* 25.0-39.9 GRT (beyond 8 nm offshore), 40.0-70.0 GRT (15 nm offshore), and above 70.0 GRT (above 30 nm offshore). Two types of methods are adopted during purse seine operations, *i.e.* using fish agregating devices (FADs) and without FADs or free searching (free school). FADs are normally set in areas where the water depths exceed 40 m. Luring materials for FADs are made from coconut leaves anchored using several concrete sacks.

Table 1. Number of purse seine vessels in Malaysia (2012-2013)

Area	2012	2013
East Coast of Peninsular Malaysia	495	487
West Coast of Peninsular Malaysia	441	443
Sabah	301	274
Sarawak	43	34
Total	**1,280**	**1,238**

Myanmar

The fisheries sector in Myanmar is one of the major components that significantly contribute to the country's economy. Fish provides a major source of animal protein in the diet of Myanmar people who largely consume rice and fish in their daily life with annual fish consumption of about 51.0 kg per capita in 2012. As promulgated, the Myanmar Special Economic Zone for Marine Fishing has been established from the shoreline to 200 nautical miles offshore. The territorial sea of Myanmar extends 12 nautical miles from the shoreline. The total area of its fishing ground including its EEZ is about 486,000 km^2. Myanmar's coastline is divided into three coastal regions, namely: Rakhine Coastal Region, the Ayeyarwady and Gulf of Mottama (the Delta Zone), and Tanintharyi Coastal Region (**Fig. 7**). The country's marine capture fisheries sector is categorized into two major types: coastal or inshore fisheries, and offshore or deep-sea fisheries.

Purse seine is a major fishing gear used to exploit the pelagic fish resources of the waters of Myanmar. The two main types

Fig. 7. Map of Myanmar showing its coastal regions

of purse seines employed in Myanmar waters are fish purse seine to catch pelagic species like hilsa, and anchovy purse seine (two-vessel seine) to catch anchovies and operate in coastal waters, especially in the northern area of Rakhine State. Most fish purse seine vessels are about 50 to 100 GRT, and are operated in a traditional manner without the use of FADs. Most purse seiners have a skipper with expertise in searching fish schools using sonar. Hilsa is the major species caught by purse seine from October to May. Anchovy purse seine vessels are normally operated by two vessels in shallow inshore areas and mainly target the anchovies *Stolephorus* spp. **Table 2** shows the landings of anchovy purse seine fisheries in Myanmar.

Light luring is also used in purse seines to attract free-schooling fish at night, and mainly harvesting the small mackerels and sardines, particularly along the northern coast of Rakhine Coastal Region. **Table 3** shows the number of purse seine vessels operating in the offshore waters of Myanmar.

Philippines

In 2011, the Philippines ranked 11th among the top fish producing countries in the world with total production of 4.97 million MT comprising fishes, crustaceans, mollusks, and aquatic plants, contributing about 3.0% to the total world production of 178.2 million MT. In 2012, the Philippines' total fisheries production of 4.87 million MT was about 2.2% lower compared with the previous year's production. Three major fishing sectors contributed to the country's annual fisheries production, namely: the commercial sector with increased production of 0.9% (1.04 million MT) compared to previous year's production of 1.03 million MT, the aquaculture sector which produced 2.5% lower than the previous year's level, and the municipal sector with production that reduced by 3.9% during the same period. The country's fishing industry employs a total of 1,614,368 fishing operators and fishers nationwide of which the municipal fisheries sector accounted for more than one million (1,371,676), while the commercial and aquaculture sectors added some 16,497 and 226,195 operators and fishers, and fish farmers, respectively.

The growth of Philippine fisheries production showed a decreasing trend from 5.1 million MT in 2009 to 4.7 million MT in 2013 (SEAFDEC, 2015). In terms of value, the country's fisheries production in 2013 was valued at US$5.4 billion (about 245 billion Philippine Pesos (PHP); US$1.00=PHP45.00) had increased compared to US$4.3 billion (or PHP 194 billion) in 2009. The major fishery

Table 2. Landings of anchovy purse seine fisheries (2005-2014) of Myanmar

Year	Number of vessels	Catch (MT)				Total (MT)
		Anchovy	Sardines	*Rastrelliger* spp.	Others	
2005-2006	368	4,505	1,457	100	1,030	7,092
2006-2007	377	1,978	1,842	30	3,857	7,707
2007-2008	375	5,024	1,028	58	3,022	9,132
2008-2009	374	6,188	2,215	44	2,170	10,617
2009-2010	375	6,973	3,216	20	3,998	14,215
2010-2011	377	7,873	3,926	32	4,301	16,132
2011-2012	366	5,031	1,816	53	5,812	12,712
2012-2013	362	4,205	2,510	79	4,098	10,892
2013-2014	360	2,156	4,773	124	6,899	13,952

Table 3. Number of purse seine fishing vessels of Myanmar engaged in offshore fisheries

No	Type of Gear	Year					
		2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013
1	Fish Purse Seine	152	158	161	168	273	278
2	Anchovy Purse Seine	375	374	375	377	366	362

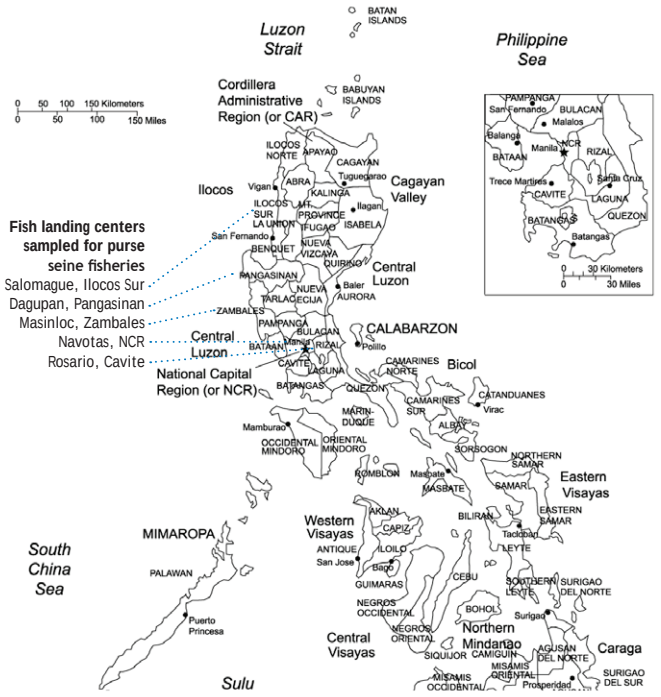


Fig. 8. Map of the Philippines showing the fish landing centers used for sampling purse seine fisheries

resources exploited in the Philippines are the small pelagic species, tunas and other large pelagic fishes, demersal fishes, and invertebrates. The country's small pelagic fisheries have been contributing significantly to its total fisheries production, and are also considered the major source of inexpensive animal protein for lower-income groups of people in the Philippines. In 2003, the Philippines established four sampling sites in landing centers of purse seines and ringnets as the target fishery in the South China Sea (**Fig. 8**). These are in Rosario (Cavite), Navotas (National Capital Region or NCR), Masinloc (Zambales), and Salomague (Ilocos Sur). Sampling in Masinloc and Salomague was however discontinued effective August 2003 as the purse seine landings have indicated deficiency of the five target species. Subsequently, Dagupan fish landing was added to cover the major landings of roundscads as well as mackerels from the Danish seine fishery in Lingayen Gulf. In 2013, there were 73,464 fishing gears operated by 68,315 small-scale fisheries, fisherfolk associations and cooperatives. **Table 4** shows the distribution of the country's fishing gears.

Table 4. Distribution of fishing gears in the Philippines

Fishing gears	Units
Gillnets	16,404
Hook and lines	9,449
Lambaklad	7
Fishpots	3,659
Payao	1,828
Squid jigger	1,005
Motorized bancas	1,044
Fish traps	488
Multiple handlines	2,842
Tuna handlines	4,122
Marine engines	4,019
Crab lift nets	2,000
Crab pots	24,297
Non-motorized bancas	1,674
Others	626

Thailand

Several years before 2007, Thailand was among the top ten countries in terms of marine capture fisheries production with annual landings of more than 2.5 million MT, but this figure had slightly decreased since then. Apart from the changing of catch report format where catch from waters outside the country's EEZ had been excluded from the national marine capture production statistics, the decreasing fishery resources became a major issue. The EEZ of Thailand covers 420,280 km^2: 304,000 km^2 in the Gulf of Thailand (GoT) and 116,280 km^2 in the Andaman Sea Coast of Thailand (ASCoT). There are 23 coastal provinces surrounding these two main fishing areas, 17 of which are in the GoT with total coastline of approximately 2,700 km, and 6 provinces in ASCoT covering 865 km of coastline. The fishing grounds are divided into seven (7) zones, namely: zone 1 to zone 5 in the GoT, and zone 6 to zone 7 in the ASCoT (**Fig. 9**).

Catches from the Gulf of Thailand and Andaman Sea together make up the country's total production from marine capture fisheries. Currently however, such production showed decreasing trend from both fishing grounds. In 2011, the total pelagic catch was 564,956 MT of which GoT contributed 70% and ASCoT shared the other 30% (**Fig. 10**, **Table 5**).

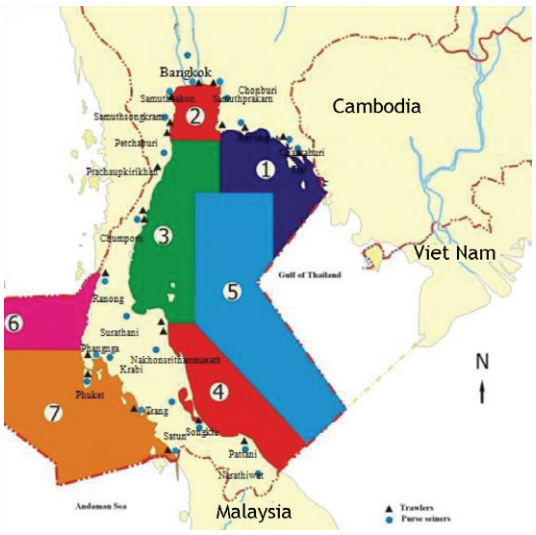


Fig. 9. Fishing zones in Thailand waters

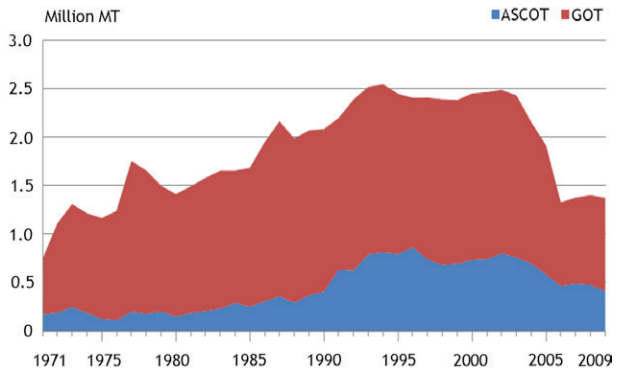


Fig. 10. Total pelagic catch from GoT and ASCoT

Table 5. Catch of marine capture fisheries (2011)

Category	Catches (MT)	Percentage (%)
Pelagic fish	564,956	41.2
Demersal fish	144,881	10.6
Cephalopod	138,344	10.0
Crustacean	76,714	5.6
Other food fish	108,297	7.9
Other miscellaneous fishes	51,006	3.7
Trash fish	287,430	21.0
TOTAL	**1,371,628**	**100.0**

In 2011, the Marine Fisheries Research and Development Bureau (MFRDB) of the Department of Fisheries of Thailand conducted a survey of the country's fishing grounds, and the corresponding database has been revised regularly in order to publish up-to-date data. Based on the current database, there are 56,979 fishing vessels, 60% of which are small-scale fishing vessels. Purse seines are the major fishing gear used for catching pelagic fishes in coastal areas. The total number of purse seine vessels as of 2011 was 1,641 comprising small vessels (10-25 m) and large vessels (>25 m). In 2011, a total of 1,224 vessels were operating in GoT and 417 vessels in ASCoT (**Table 6**).

Thailand's purse seine fisheries could be categorized into six types (**Table 7**), namely: Thai purse seines (TPS), coconut leaves luring purse seines (LPS), light luring purse seines (LLPS), day-anchovy purse seines, night-anchovy purse seines, sardines purse seines, silverside purse seines, and acetes purse seines. TPS, LPS and LLPS are the major types of purse seines and commonly found in the GoT and ASCoT. TPS, LPS and LLPS mostly employ 1.0 inch mesh size nets to harvest common pelagic fishes. However, some TPS use 4.0-inch mesh size nets to target neritic tunas.

Viet Nam

Viet Nam has a coastline of 3,260 km and the EEZ that covers more than one million km^2. Based on its natural characteristics, the waters of Viet Nam could be divided into five regions, namely: Gulf of Tonkin, Central waters, Southeast waters, Southwest waters, and Central of Bien Dong (**Fig. 11**). Its fisheries sector plays an important role in the country's social and economic development contributing 3% to the GDP of Viet Nam, and fish provides about 40% of the animal protein consumption of its people.

Table 6. Number of purse seine vessels by size operating in the waters of Thailand (2011)

Type of Gear	Number of vessels by length				
	Total	10-14 m	14-18 m	18-25 m	>25 m
ASCoT	417	47	78	271	21
GoT	1,224	231	171	759	63
Total	**1,641**	**278**	**249**	**1,030**	**84**

Table 7. Total number of purse seine by types in Thailand

Type of purse seines	Total number	Number of vessel by Areas	
		GoT	ASCoT
Thai purse seine, TPS	584	373	211
Luring purse seines	534	422	112
Coconut leaves luring purse seine, LPS	344	315	29
Light luring purse seine, LLPS	190	107	83
-lamp	6	5	1
-electric bulb	184	102	82
Anchovy purse seines, APS	484	396	88
Sardines purse seine	19	18	1
Silverside purse seine	14	14	-
Acetes purse seine	6	1	5
Total	**1,641**	**1,224**	**417**

Fig. 11. Map of Viet Nam showing Gulf of Tonkin and other coastal regions

Starting with traditional fishing with small artisanal vessels operating mainly in near-shore areas, marine capture fisheries of Viet Nam has developed rapidly, while fishing efficiency and the quality of marine catches have also improved considerably. Policies established by the Government for offshore fishing and resources stability in coastal areas encouraged fishing operators to invest in building new vessels with high engine capacity to explore fishing operations in open seas. Thus, the number of fishing vessels had increased from 79,996 to 128,363 in 2002 to 2011, respectively but started to decrease in 2011 (**Table 8**).

The annual total catch from marine capture fisheries in Viet Nam had increased during the past decade. From a total catch of about 1.99 million MT in 2005, this increased to 2.59 million MT in 2007, and further increased to 3.12 million MT in 2009 (**Table 9**). During 2007-2009, the catch from purse seine fisheries was about 16-22% of the country's total annual catches.

Purse seine is one of the most important types of fishing gear for marine capture fisheries in Viet Nam. It is also one of the potential fishing gears for offshore fishing operations. Marine production from purse seine fishery is about 20.6% of the country's total marine catch. The main species landed by local and commercial purse seine operations are small pelagic fishes comprising sardines, mackerels, roundscads, skipjack, and anchovy, among others. The country's purse seine fishery makes use of two types of fishing methods, either using luring techniques or searching method. Based on the structure and size of the nets, the country's purse seine could be categorized into searching purse seine for catching small pelagic fishes or tuna.

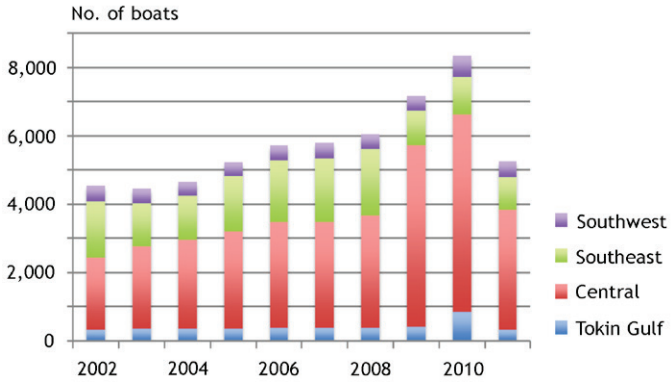


Fig. 12. Number of purse seine vessels in Viet Nam (by fishing areas)

Fig. 12 shows the number of purse seine fishing vessels in Viet Nam from 2002 to 2011, which had its lowest in 2003 (4,471 units) and highest in 2010 (8,348 units). Contributing about 4.1-6.9% of the country's total fishing vessels, purse seine fisheries are well developed, especially in the Central and the Southeast waters. Purse seine fisheries in the Gulf of Tonkin and the Southwest waters have been quite stable throughout the last decade. In the Central waters, the number of purse seine vessels were observed to increase from 2002 to 2010 while those in the Southeast waters, the number has been fluctuating with the highest number recorded in 2008.

Table 8. Total number of fishing vessels in Viet Nam

Year	Total number of fishing vessels	Year	Total number of fishing vessels
2002	79,996	2008	99,589
2003	75,053	2009	120,326
2004	71,905	2010	128,021
2005	80,968	2011	128,363
2006	85,705	2012	123,125
2007	84,224	2013	117,016

Table 9. Annual catches of the marine capture fisheries in Viet Nam by fishing areas

Year	Annual catches (MT)				Total
	Gulf of Tonkin	Central waters	Southeast waters	Southwest waters	
2007	386,838	724,097	937,903	544,829	2,593,667
2008	416,507	1,100,997	918,066	436,860	2,872,430
2009	553,377	1,103,883	910,130	550,164	3,117,554

Conclusion and Way Forward

Small pelagic fishes such as the Indian mackerels, scads and sardinellas are commercially-important commodities in the Southeast Asian region. In 2010 for example, more than 800,000 MT of mackerels (*Rastrelliger* spp.), 700,000 MT of scads (*Decapterus* spp.) and 800,000 MT of sardinellas (*Sardinella* spp.) were captured in the waters of Southeast Asia. Capture fisheries targeting these fishes are of fundamental importance to the Southeast Asian region in terms of employment and livelihood of fishers. Purse seine is one of the major fishing gears used to catch small pelagic fishes. However, management of purse seine fisheries has not yet been developed because information on the stocks is still inadequate.

Expanding the catches of small and large pelagic species by purse seine fisheries could still be carried out as long as national governments enforce control and management of their respective fishing fleets. It is therefore necessary to establish a management plan, although such effort would require developing the best way to assess the size and state of the stocks for accurate total allowable catch (TAC) allocation and to find the most applicable TAC system for purse seine fisheries in the Southeast Asian region. Considering the likelihood that such stocks are shared by the bordering countries with the same ecosystems, *i.e.* of the Andaman Sea and the South China Sea, effective management of the shared stocks would require appropriate measures to be taken for the whole coverage areas which are beyond the national waters.

In an effort to attain the aforementioned goal, SEAFDEC/MFRDMD embarked on a five-year project in 2013 on Comparative Studies for Management of Purse Seine Fisheries in the Southeast Asian Region. With the cooperative involvement of the eight aforementioned countries, the project compiles and compares the region's annual and/or monthly CPUE where data are available for the last three decades.

The project would analyze and benchmark such information with the purse seine fisheries management systems/measures including TAC systems and other management measures that have been successfully adopted in the world's fisheries. Moreover, the project would also carry out a genetic study of commercially-important pelagic species, and develop management strategies for sustainable purse seine fisheries in the Southeast Asian region.

Considering that catch-effort statistics are available in Malaysia and Thailand, and CPUE is an indirect measurement of abundance of a target species in fisheries, MFRDMD has attempted during the last three decades, to examine the trend of resource level using the CPUE. At the same time, MFRDMD is also reviewing the purse seine fishery management systems including TAC systems and other management measures in the world to examine which management system/measure is applicable for the management of small pelagic fisheries in the Southeast Asian region.

As for the genetic study, this is aimed at verifying the extent of connectivity of commercially-important pelagic species targeted by purse seine fisheries, and providing the scientific background for concerted management actions of the SEAFDEC Member Countries for shared stocks of small pelagic species. The results would also be used for the development of appropriate management of purse seine fisheries in the Southeast Asian region. It is expected that by the end of the MFRDMD Project, a review of the available information including stock levels would be at hand to be used by the Member Countries in evaluating the management strategies for sustainable purse seine fisheries for the Southeast Asian region.

It should be noted that this MFRDMD Project corresponds to ASEAN-SEAFDEC Resolution #10 which encourages the ASEAN and SEAFDEC to "*strengthen knowledge/science-based development and management of fisheries through enhancing the national capacity in the collection and sharing of fisheries data and information*," and Plan of Action #22 on the need to "*establish and strengthen regional and sub-regional coordination on fisheries management and efforts to combat IUU fishing including the development of regional/sub-regional Monitoring, Control and Surveillance (MCS) networks*."

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Coping with Overcapacity/Overfishing: Experience of Japan

Tsuyoshi Iwata and *Virgilia T. Sulit*

Preventing the incidence of over-exploitation is a central element of fisheries management. Therefore, fisheries managers should be able to comprehend the degree of exploitation in a fishery resource and if managers fail to take appropriate actions to avoid over-exploitation of the resource, they do not fulfill the goal of a very important mission, which is making sustainable utilization of fishery resources come true. Although fisheries managers are working with fishers and other relevant stakeholders who are making money from the fishery resources, in reality it is not an easy task to undertake fisheries management by limiting the fishing capacity at an appropriate level and avoiding and/or addressing the problem of overcapacity which undermines the longer term sustainability of the fishery resources. Then, how should fisheries managers work on such a challenging task? The International Plan of Action for the Management of Fishing Capacity adopted by the FAO Committee on Fisheries in 1999, urges FAO Member Countries to apply a three-phase implementation scheme while tackling with management of fishing capacity in their respective countries (FAO, 2008). These phases are: (1) assessment and diagnosis; (2) adoption of preliminary management measures; and (3) system of periodic reviews and adjustments. This article is therefore aimed at making a commentary for readers to comprehend the efforts of Japan in managing fishing capacity and in avoiding the occurrence of overfishing, which the Southeast Asian countries could refer to in managing their respective fisheries and preventing overcapacity as well as overfishing. Firstly, the institutional system of Japan's fish stock assessment are explained, and then, the Pacific Bluefin Tuna (PBFT) is referred to as a typical case of Japan's endeavor in eliminating overfishing.

Compiled based on the presentation of Mr. Tsuyoshi Iwata during the Regional Technical Consultation on Development of Regional Plan of Action-Management of Fishing Capacity organized by SEAFDEC in February 2015 in Kuala Lumpur, Malaysia, this article does not represent the views of the Fisheries Agency of Japan. The authors are solely responsible for the contents including the descriptions used in this article.

Framework for Assessment of Fishery Resources in Waters Surrounding Japan

The Fisheries Research Agency (FRA) of Japan carries out every year, an assessment of stocks of main fishery resources in the waters surrounding Japan. In 2013, FRA conducted the assessment of 84 stocks of 52 species. However, assessment of the so-called "International Stocks" such as the highly migratory species, *e.g.* tuna and tuna-like species, and anadromous species, *e.g.* salmons are covered by other frameworks of stock assessment being implemented in Japan in close coordination with relevant international bodies. The chronological changes in the results of the assessment showed that the proportion of low-level stocks had been decreasing while the medium-level stocks had been increasing as shown in **Fig. 1**.

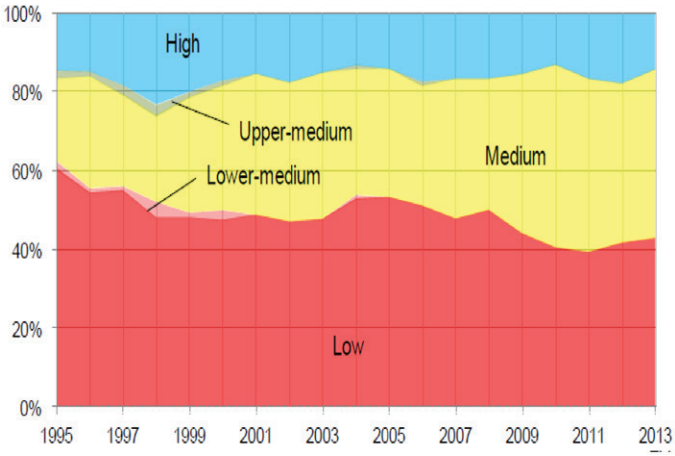

Fig. 1. Changes in the results of marine fishery resources assessment in Japan (FAJ, 2014b)

Based on the results of the stock assessments, the Fisheries Agency of Japan (FAJ) explained that the fishery resources in waters surrounding Japan is generally stable (FAJ, 2014a). In addition to the efforts of FRA to carry out stock assessment at the national scale, the Fishery Experimental Stations and Research Centers in 39 coastal prefectures all over Japan are also committed to conduct stock assessment on their own. The target species of the Prefectural Stock Assessments are typically the sedentary but local commercially-important resources (**Fig. 2**), *e.g.* bivalves, sea cucumber, and flatfish.

Strengths of the Fishery Resources Assessment in Japan

Considering that in Japan, most of fishers' catch are sold through fishers' organizations, *e.g.* Fisheries Cooperative Associations, collection of data at landing sites is relatively easy. This leads to reliable national fisheries statistics of Japan which is compiled by the Statistics Department of the Ministry of Agriculture, Forestry and Fisheries. Moreover, well-established research institutes and their networks including the FRA, Prefectural Experimental Stations and universities are always at hand to collaborate in the stock assessment activities, by providing the necessary resources needed for stock assessment, *e.g.* human resources and infrastructures (**Fig. 3**).

Fig. 2. Examples of target species for the Prefectural Stock Assessments in Japan: bivalves (*left*), sea cucumber (*center*), and flatfish (*right*)

Fig. 3. (*left*) Staff of Fisheries Research Centers collect catch data at a landing site *(Source: Kumamoto Prefecture)*; and (*right*) Fishery Research vessel dispatched for stock sampling surveys *(Source: Fisheries Research Agency of Japan)*

However, still many challenges confront the stock assessment activities in Japan. These include difficulties in securing sufficient budgetary allocations and maintaining the experienced staff, considering that the financial situation in Japan both in central and local governments had been getting worse during the recent years. In order to mitigate such hardships, activities that aim to raise the awareness of tax payers and policy makers on the importance of fisheries research have been strengthened.

How Japan is coping with Overcapacity/ Overfishing? A case of the Pacific bluefin tuna

The Pacific bluefin tuna (*Thunnus orientalis*) is a commercially valuable species. In fact, the average wholesale price of bluefin tuna (Pacific and Atlantic bluefin tuna) sold at Tsukiji Fish Market (**Fig. 4**) in 2015 was 3,792 Japanese Yen per kg (about 31.60 USD/kg). In view of its high quality meat, bluefin tuna is mainly consumed and eaten raw, *i.e.* sushi and sashimi. It is assumed that Japanese fishing vessels accounts for about 70% of world's Pacific bluefin tuna (PBFT) catch. Since PBFT migrate the whole temperate waters of the Pacific Ocean, it is also caught by fishing vessels of other countries, *e.g.* Mexico, Korea, and majority of the foreign catch are brought into Japanese market to be used as sushi and sashimi ingredients. This implies that Japan has a big responsibility for the sustainable utilization of PBFT stocks not only as a major fishing but also as a big market country (FAJ, 2013).

As the scientific body responsible for international stock assessment of PBFT, the International Scientific Committee for Tuna and Tuna-Like Species in the North Pacific Ocean (ISC) indicated that the PBFT biomass level for 2012 is nearing the historically low levels and there is a need to reduce catch of juveniles by 50% in order to restore the stock to historically medium level. Following the recommendation of ISC, the Western and Central Pacific Tuna Fisheries Commission (WCPFC) adopted a management measure of reducing the catch of juvenile PBFT (less than 30 kg) by 50% starting in 2015. This measure applies to tuna fisheries in all the WCPFC convention area including Japan's EEZ. Thus, Japan is responsible for the success of this management measure as a major fishing country as well as a major market country, the country of "sashimi eaters." As a major fishing/market country of PBFT, Japan through the FAJ has been determined to implement this drastic management measure and tackle the 50% reduction of juvenile PBFT (less than 30 kg) in Japanese fisheries. The strategy adopted by FAJ is to involve all fishers who catch PBFT, in this drastic PBFT management measure without any exception.

Fig. 4. First auction of 2015 for bluefin tuna at Tsukiji Fish Market, Tokyo

Guided by the firm belief that PBFT resource could be restored if it would implement appropriate management measures, as in the successful case of the Atlantic Bluefin Tuna restoration introduced and implemented by the International Commission for the Conservation of Atlantic Tunas (ICCAT), FAJ put into effect a regulation imposing that all relevant fisheries must abide by the said catch reduction measure. Moreover, FAJ enforced that there should be no "free riders" to such regulation, *i.e.* fishers who are free from the catch reduction scheme, thereby benefiting from other fishers' catch reduction effort. It should be recalled that more than 90% of PBFT catch in Japan are juveniles (less than 3 years old). PBFT are caught by trawling

Box 1. Legislative and Institutional Systems regarding Fishing Capacity Management of Japan

1. Fishery Right System in Coastal and Inland Water Fishing Grounds

(Based on Fisheries Law, Prefectural Governors grants, Fishery Rights to qualified applicants)

- The Prefectural Governor designates coastal and inland fishing grounds which are suitable for establishing Fishery Rights. Then, the Governor will grant Fishery Rights to qualified applicants. There are 3 types of Fishery Rights.

Fishery Rights	Type of Fisheries/Aquaculture	Qualified/legal person	Duration
Common Fishery Rights	Fishery for Sedentary Aquatic Species, Small Scale Fixed Net, Inland Water Fisheries, etc	Fisheries Cooperative Associations (FCAs)	10 years
Demarcated Fishery Rights	Any Aquaculture Operation in public waters	FCAs or Private Aquaculture Business (person/legal person)	10 years or 5 years
Fixed Net Fishery Rights	Large Scale Set Net Fisheries (depth of the catching net exceeds 27 m, etc.)	Private Fishery Business (person/legal person)	5 years

- Persons/Legal Persons who are granted Fishing Rights are responsible for maximizing fishery production in the designated area through realization of well-coordinated fishing activities
- For this purpose, Fisheries Cooperative Associations (FCAs) who are granted fishing rights will establish autonomous regulations titled "Fishery Right Exercise Rule"
- Fishery Right Exercise Rule determines conditions of fishing operation in the designated area, such as: seasonal closure of fisheries; closure of fishing ground; number of fishers eligible for designated fishery, thereby sustaining well-organized fishing operations by each FCA member (fisher), as well as preventing overfishing in the area of Fishery Right

2. Fishery License System

2.1 License of Designated Fisheries, etc.

(Based on Fisheries Law, Minister of Agriculture, Forestry and Fisheries issues licenses for operation of Designated Fisheries)

- As for large scale offshore and distant water fisheries, it is necessary to implement rigid control measures of fishing capacity (*i.e.* number of fishing vessels, size and engine power of fishing vessels, etc) in order to secure sustainable utilization of target resources
- These large scale fisheries typically operate in waters off the coast of multiple Prefectures or even in International Waters, and thus are suitable for nation-wide uniformed regulation by the responsible Minister
- 13 types of fisheries are designated by Government Ordinance (based on Fisheries Law), so these fisheries are called "Designated Fisheries". The Minister issues licenses for operation of Designated Fisheries. Examples of Designated Fisheries: Trawl fishery (Vessel Size ≥15 tons), Purse Seine Fishery (≥40 tons), Skipjack Baitboat Fishery (≥10 tons), Tuna Longline Fishery (≥10 tons), Squid Jigging Fishery (≥30 tons), Salmon Drift Net Fishery (≥30 tons)
- Persons/Legal Persons who want to operate Designated Fishery have to receive licenses issued by the Minister
- The Minister determines maximum number of fishing vessels or maximum total gross-tonnage of fishing vessels for each fishery, and licenses are issued within such limitations
- The Minister imposes restrictions/conditions on the license, such as: size of fishing vessels; prohibited area; and prohibited season, thereby securing sustainable fishing operations
- There is one more category of fisheries under the Minister's direct control, which is called "Specific Fisheries with Minister's License" (5 fisheries including Snow Crab Trap Fishery and Deep Sea Gill Net Fishery in the Pacific)
- These fisheries are deemed not necessary to impose such rigid management measures as on Designated Fishery, but need to limit number of engaging fishing vessels, and the Minister issues licenses for operation of these fisheries

2.2 Fisheries licensed by Prefectural Governors

(Based on "Fisheries Coordination Regulation" established by Prefectural Governors according to related articles of "Fisheries Act " and "Act on Protection of Fisheries Resources", Prefectural Governors issue fishing licenses)

- As for fisheries outside of the scope of Minister's control, Prefectural Governors can impose necessary regulations for well-organized fishing operations and for conservation and management of fishery resources off the coast of the Prefectures
- Prefectural Governors itemize fisheries which require Governor's license. Fishers granted such fishing licenses have to operate in accordance with "Fisheries Coordination Regulation*" as well as conditions/restrictions imposed on the license

3. Fisheries Notification System

(Minister of Agriculture, Forestry and Fisheries requires notification from the fishers for engaging in specific fisheries, based on Ministerial Ordinance (established according to "Fisheries Law" and "Law on Protection of Fisheries Resources"))

- As for fisheries which do not need licenses and which are out of scope of Fishery Rights, any fishers of Japanese Nationality (including legal person) can freely operate fishing activities
- As for fisheries Minister considers it necessary to monitor states of fishing operations, the Minister requires notification from fishers for engaging in such fisheries as well as mandatory report of fishing activities

4. TAC System

(Based on "Act on Preservation and Control of Living Marine Resources", Minister of Agriculture, Forestry and Fisheries and Prefectural Governor take charge of TAC management)

- The Minister determines Total Allowable Catch (TAC) for7 kinds of fish every year
- The 7 kinds are: Saury; Walleye Pollock; Sardine; Mackerel (Chub Mackerel and Spotted Mackerel); Jack Mackerel; Japanese Common Squid; and Snow Crab
- These kinds of fish is designated as TAC controlled fishes mainly because of (1) importance for national economy, and (2) availability of sufficient scientific information to determine TAC

Box 1. Legislative and Institutional Systems regarding Fishing Capacity Management of Japan (Cont'd)

4. TAC System (Cont'd)

- TACs are established annually based on Allowable Biological Catch (ABC), as well as in consideration of status of fishery business management
- Allocation of TAC is divided into the following 2 categories: (1) Fisheries under control of the Minister such as (a) Designated Fisheries and (b) Specific Fisheries with Minister's License), the amount of TAC allocation of which is determined fishery by fishery; and (2) Fishery under control of Prefectural Governors such as (a) Fisheries under Fisheries Right and (b) Fisheries licensed by Governors, the amount of TAC allocation of which is determined prefecture by prefecture
- Fishers who catch TAC species are responsible for reporting amount catch though Fisheries Cooperative Associations (FCAs) and other fisher's organizations.
- The Minister and Prefectural Governors are responsible for monitoring accumulated catch for TAC species and take necessary measures including order of ceasing fishing operations.

5. TAE System

(Based on "Act on Preservation and Control of Living Marine Resources", Minister of Agriculture, Forestry and Fisheries takes charge of TAE management)

- In order to support "Resources Recovery Plan"(Action Plan for cooperation of every stakeholders (fishers, managers, scientists, distributors etc.) with the aim of urgent actions toward restoration of depleted fishery resources), the Minister determines Total Allowable Effort (TAE) of target species by designated fishery in the designated area
- Typically, TAE is in the form of "Number of Fishing Vessels multiplied by Fishing days"
- The Minister notifies establishment of TAE to relevant Prefectural Governors every year, thereby supporting Prefectural Governor's control of fishing efforts towards target species

6. Control Systems of Fishing Vessels

6.1 Permission for Construction of Fishing Vessels

(Based on "Fishing Vessel Act", Ministry of Agriculture, Forestry and Fisheries or Prefectural Governors grant permission for Fishing Vessel Construction.

- In order to ensure well-ordered fishing operations, permission of the Minister or relevant Prefectural Governor is required for construction of any fishing vessels equipped with engine and whose length is 10 m and more
- As for construction of fishing vessels which needs Minister's license for their fishing operation, permission of the Minister are required
- As for construction of fishing vessels which needs Prefectural Governor's license for their fishing operation, permission of the Prefectural Governors are required
- As for construction of fishing vessels which does not need any license for its fishing operation: Minister grants permission for construction of vessels 20 gross tons and more; and Prefectural Governor grants permission for construction of vessels less than 20 gross tons

6.2 Registration of Fishing Vessels

(Based on "Fishing Vessel Act", Prefectural Governors takes charge of fishing vessels registration)

- All fishing vessels equipped with engine and whose size are 1 gross ton and more have to be registered in the "Fishing Vessels Registration List", and receive a "Fishing Vessel Registration Card"
- Prefectural Governors are responsible for compiling Fishing Vessels Registration List as well as issuing Vessels Registration Card for vessels which have base of operation within the area of the prefecture
- To confirm that actual status of a fishing vessel is in line with the contents of Vessel Registration Card, the vessel owners have to undergo a vessel inspection every 5 years

7. Other Regulations Related to Fishing Capacity Management

7.1 Restriction of Fishing Gears/Fishing Methods used by non-fisher people

(Based on "Fisheries Coordination Regulations", Prefectural Governors takes charge of this regulation)

- "Fisheries Coordination Regulations*" of all 47 prefectures in Japan stipulates "Restriction of Fishing Gears/Fishing Methods used by non-fisher people"
- By this regulation, fishing gears/methods allowed for "ordinary people" (non-fishers) are itemized in the regulation. Typically, Pole Fishing, Handline Fishing, Casting Net, Small Scoop Net, Fish Lance, Shellfish Tearing Devices, etc, are itemized in the regulation
- Through this regulation, eligible people to use effective fishing gears/methods is limited to fishers, which has effects to prevent excessive utilization of fisheries resources in coastal and inland fishing grounds

7.2 Regulation on activities of Foreign Fishing Vessels in Japanese Port

(Based on "Act on Regulation of Fishing Operation by Foreign Nationals", Minister of Agriculture, Forestry and Fisheries takes charge of this regulation)

- Foreign Fishing Vessels are not allowed to carry their catch (fish) directly from the fishing ground into Japanese Port. If they want to carry fish and enter into Japanese Port, the fish have to be accompanied by "certifications of foreign country's authorities" which certify that the fish had been shipped from foreign ports
- This regulation prohibits utilization of Japanese Port as "fishing bases" of foreign fishing vessels, thereby preventing excessive fishing pressures by foreign fishing vessels in waters surrounding Japan.

8. Enforcement of Regulations related to fishery

- Fisheries Enforcement Officers are appointed both from FAJ and all Prefectural Offices. Enforcement officer of FAJ serve as "National Fisheries Enforcement Officers", whereas Enforcement officers of Prefectural Government serve as "Prefectural Fisheries Enforcement Officers"
- To attain "compelling power" which is of vital importance for effective enforcement of regulations, Fishery Enforcement Officers are in close cooperation with relevant Law-Enforcement Organizations, including Coast Guard and Prefectural Police

Fig. 5. Growth of Pacific Bluefin Tuna
Adult fish (*left*), fish with 60 cm fork length (*middle*), and (*right*) fish with 20 cm fork length (Source: Fisheries Research Agency of Japan)

line fishery catching less than one (1) year old juveniles for sashimi-tuna and aquaculture seed stock; purse seine fishery catching 1-3 year old juveniles for sashimi-tuna; handline fishery catching adults more than 4 years old for highest quality sashimi-tuna; and other fisheries mainly the set net fishery.

Implementation of PBFT Catch Reduction Measure

In implementing the drastic catch reduction measure for PBFT, FAJ convened a number of consultations with fishers to make them understand the rationale of the said measure and to obtain their support to reduce the catch of PBFT juveniles. FAJ also intends to be transparent in the implementation of the measure which should be fair to all fishers. Following intensive discussions with fishers, FAJ decided to introduce the nation-wide measure to reduce catch of juvenile PBFT (less than 30 kg) by half (from 8,015 to 4,007 metric tons of MT) starting in January 2015 (the average annual catch of Japan in 2002-2004 was 8,015 MT). The total reduced catch of 4,007 MT was divided and allocated to each fishery taking into consideration their respective previous catch records. Therefore, the allocation for purse seine fishery is 2,000 MT and 2,007 MT for the other coastal fisheries, *i.e.* trawling line, set net, and others. However, it should be considered that these data are based on information available as of February 2015.

In implementing the said catch reduction measure, FAJ introduced a Monitoring System for juvenile PBFT catch. The allocation of 2,000 MT to purse seine fishery is monitored and controlled by the Purse Seine Fishers' Organization covering each fishing area. Considering that monitoring the allocation to coastal fisheries could be complicated, FAJ authorized the Fisheries Cooperative Associations to monitor and report the catch of PBFT from coastal fisheries to FAJ. Under the newly-established reporting/monitoring system, the 39 prefectures in Japan (all prefectures facing the sea) are divided into 6 blocks, and parts of total amount (2,000 MT) are allocated to each block. FAJ compiles the reported catch amount block by block, and feedback the information on catch amount to each prefecture. Each prefecture would then relay the updated catch amount to the fishers through the Fisheries Cooperative Associations. In cases where the catch amount of each block comes close to the allocation, FAJ will issue an alert to warn the concerned block of such a situation. Each prefecture will then notify the fishers about the warning through the Fisheries Cooperative Associations, and control the fishing operation in that particular prefecture. FAJ publicizes the alert/warning to the general public by uploading it to the FAJ website or issuing announcements in press releases, with the aim of obtaining cooperation from various stakeholders, *e.g.* processers, wholesalers, retailers, consumers (FAJ, 2014c).

Challenges in Dealing with Issues of Overcapacity/Overfishing

The importance of forming an understanding and cooperative relationships with fishers is a key to the success of implementing any fisheries management measures. This is especially important taking into account the situation surrounding fisheries business management which is becoming more severe, *i.e.* higher operation costs, lower fish price. Building trust with fishers through frank and intensive exchange of views is crucial in the successful implementation of fishing capacity management measures. As for legal instruments for controlling fishing capacity, Japan has comprehensive legislative and institutional systems for fishing capacity management (**Box 1**). Although such system is surely a big advantage of Japan, what is important in introducing any fisheries management measures, is for fisheries managers to be always fair, prudent and transparent.

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Establishing Spatio-temporal Profile of Scombrid Larvae: the Philippine Eastern Pacific Seaboard in Focus

Laureana T. Nepomuceno, Rhoda S. Bacordo, Jennifer G. Viron, Riczyneth A. Arinque, Roger T. Fortaliza, and *Rafael V. Ramiscal*

Scombridae is a family of fishes consisting of 51 species in 15 genera and two sub-families all of which belong to the Sub-family Scombrinae, except the butterfly kingfish which belongs to Sub-family Gasterochismatinae. The Sub-family Scombrinae comprises four tribes, namely: Scombrini (mackerels), Scomberomorini (Spanish mackerels), Sardini (bonitos), and Tunini (tunas). Scombrids have two dorsal fins and a series of finlets behind the rear dorsal fin and anal fin. The caudal fin is strongly divided and rigid. The first (spiny) dorsal fin and the pelvic fins are normally retracted into body grooves. Lengths of the species belonging to Family Scombridae vary from 20.00 cm (7.9 in) of the island mackerel to 4.58 m (15.0 ft) recorded for the immense Atlantic bluefin tuna. Scombrids are generally considered predators of the open ocean, and are found worldwide in tropical and temperate waters. Most species of Scombrids are economically-important to the Philippines. In 2013 for example, the country's production of tunas and mackerels accounted for about 31% of the country's total production volume from marine capture fisheries and about 42% in terms of value, of which 78% of the Scombrids production volume and 80% of the value was contributed by tunas (SEAFDEC, 2015). This makes tunas the most economically-important Scombrid species for the Philippines. Establishing the spatio-temporal profile of Scombrid larvae especially in the country's Eastern Pacific Seaboard would therefore provide a picture of the abundance, distribution and diversity of Scombrid species in the Philippines.

Tunas are known to be migratory and usually rely on favorable oceanographic conditions to continue their biological processes. Environmental factors such as food availability, temperature, oxygen, and thermocline depth have been known to contribute to their abundance and distribution (SPC, 2010; FAO, 2014). The Philippine Eastern Pacific Seaboard (PEPS) has been viewed as a migration path of tunas that go along with the movements of the world's major currents.

The open-ocean current influencing the eastern side of the Philippines is the North Equatorial Current (NEC) which separates correspondingly into the Kuroshio Current and Mindanao Current on the northern and southern side of the country (Nitani 1972; Toole *et al*., 1990; Hu and Cui 1991; Qui and Chen, 2010). NEC has a velocity of 3-6 km/day with strength that extends up to the 100-200 m depth waters (Foster and Gong, 1971). The bifurcation of this current as reported by Bingham and Lukas (1995) takes place during the month of June at 13°N off Catanduanes waters. Qui and Chen (2010) indicated that the inter-annual-decadal variability of the NEC bifurcation off the Philippines shows relevance to the El Niño phenomenon, and therefore pointed out that the exact NEC bifurcation should be at 12-14°N. Qui and Chen (2010) also cited that when NEC bifurcates northerly, its surface transports tend to increase, intensifying the Kuroshio Current and Mindanao Current. Bacordo *et al*. (2012) also cited that there is a possible influence of the bifurcation of NEC on the abundance and distribution of ichthyoplankton and tuna larvae in the PEPS.

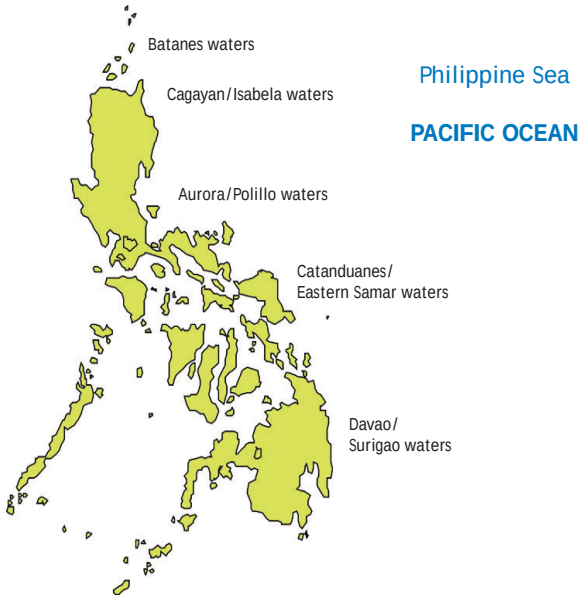


Fig. 1. Map of the Philippines showing its Eastern Pacific Seaboard and sampling stations of the case study

Considering that there has been no solid information at the national level defining the spatio-temporal abundance, composition and distribution of tuna larvae in the eastern side of the country, an analysis was therefore conducted based on the 108 samplings carried out by the M/V DA-BFAR in PEPS from 2006 to 2011. The sampling stations used for the case study stretched from Batanes in the north to Davao in the southern part of the Philippines. Oceanographic samplings were done during the months of April, May, June, and August. The sampling stations were categorized into five zones, namely: Batanes waters, Cagayan/Isabela waters, Aurora/Pollilo waters, Catanduanes/Eastern Samar waters, and Davao/Surigao waters, as shown in **Fig. 1**. The specific sampling sites are indicated in **Fig. 2**.

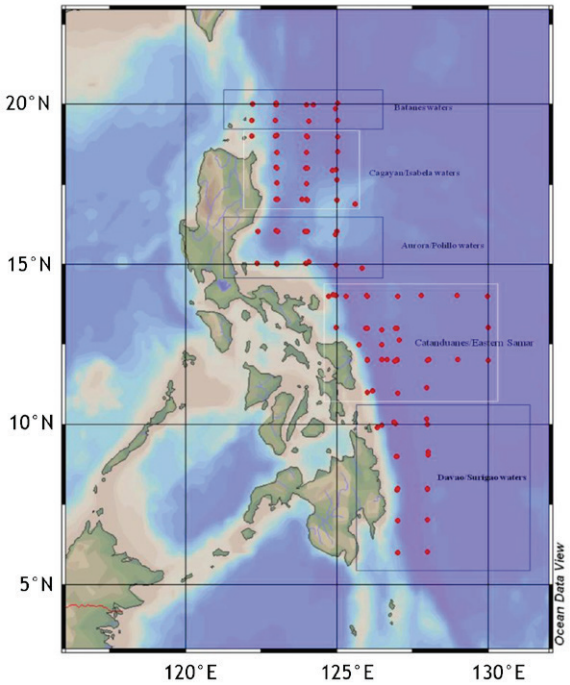


Fig. 2. Specific sampling sites for Scombrid larvae in the Philippine Eastern Pacific Seaboard

Spatio-temporal Abundance and Diversity of Scombrid larvae

The analysis which was carried out up to species-level, include the influence of food availability (phytoplankton) using the chlorophyll-*a* data compiled through the M/V DA-BFAR in relation to the total density of the Scombrid larvae. However, only the stations observed with tuna larvae were found to be related to the mean chlorophyll-*a* (1-150 m depth) as some larvae sampling stations did not coincide with the sampling stations for chlorophyll-*a*.

Thus, stations without chlorophyll-*a* data were not included in the analysis. The same method was also used to analyze the relevance of temperature to the abundance, distribution and diversity of the Scombrid larvae. For the effect of season (monthly variation) and time of day, all sampling stations were considered in order to get the average densities of Scombrid larvae. For spatial abundance, distribution and diversity of Scombrid larvae, five classified distances from the nearest shoreline were used, namely: <50 km; 51-100 km; 101-200 km; 201-300 km and > 300 km, which were obtained from the National Mapping and Resource Information Authority (NAMRIA) chart available onboard the M/V DA-BFAR. Moreover, in order to determine the zonation of the Scombrid species, data were compared with those from the abovementioned sampling stations. To determine the diversity of Scombrid species, Simpson's and Shannon's Indices were used while the density of each species by sampling area were used to determine the diversity. Correlation of Simpson's and Shannon's Indices was also analyzed to compare the results.

Abundance and Distribution of Scombrid Larvae

Results of the analysis indicated high abundance of the larvae along the Aurora/Polillo waters and Cagayan/Isabela waters with mean densities of 85 and 92 larvae/1000 m³ seawater, respectively. However, low abundance was noted along the Catanduanes/Eastern Samar waters with mean density of 24 larvae/1000 m³ seawater (**Fig. 3**). The mean densities of the Scombrid larvae from different sampling stations are shown in **Fig. 4**.

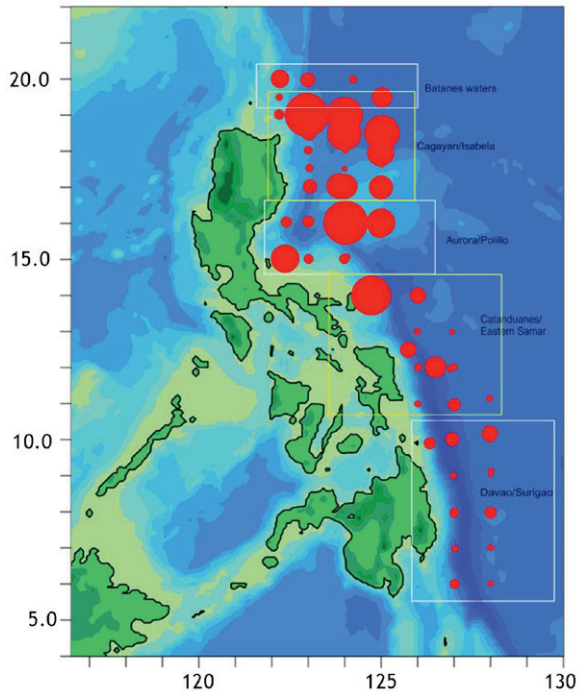


Fig. 3. Abundance of Scombrid larvae in the Philippine Eastern Pacific Seaboard with corresponding densities
(Scale: 0.025 in dia = 10 larvae/1000 m³ of seawater; 0.250 in dia= 500 larvae/1000 m³ of seawater)

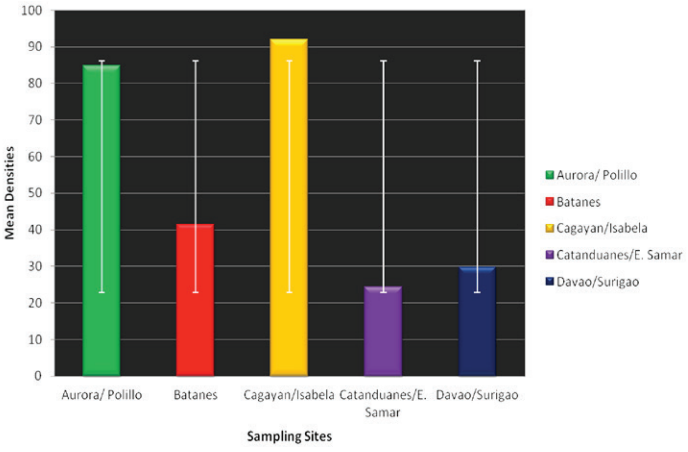


Fig. 4. Mean densities of Scombrid larvae from different sampling stations

In terms of distance from the shore, the spatial abundance of Scombrid larvae in PEPS (**Fig. 5**) suggests high abundance of larvae in stations located 201-300 km away from shore and lowest at a distance greater than 300 km from shore. Similarly,

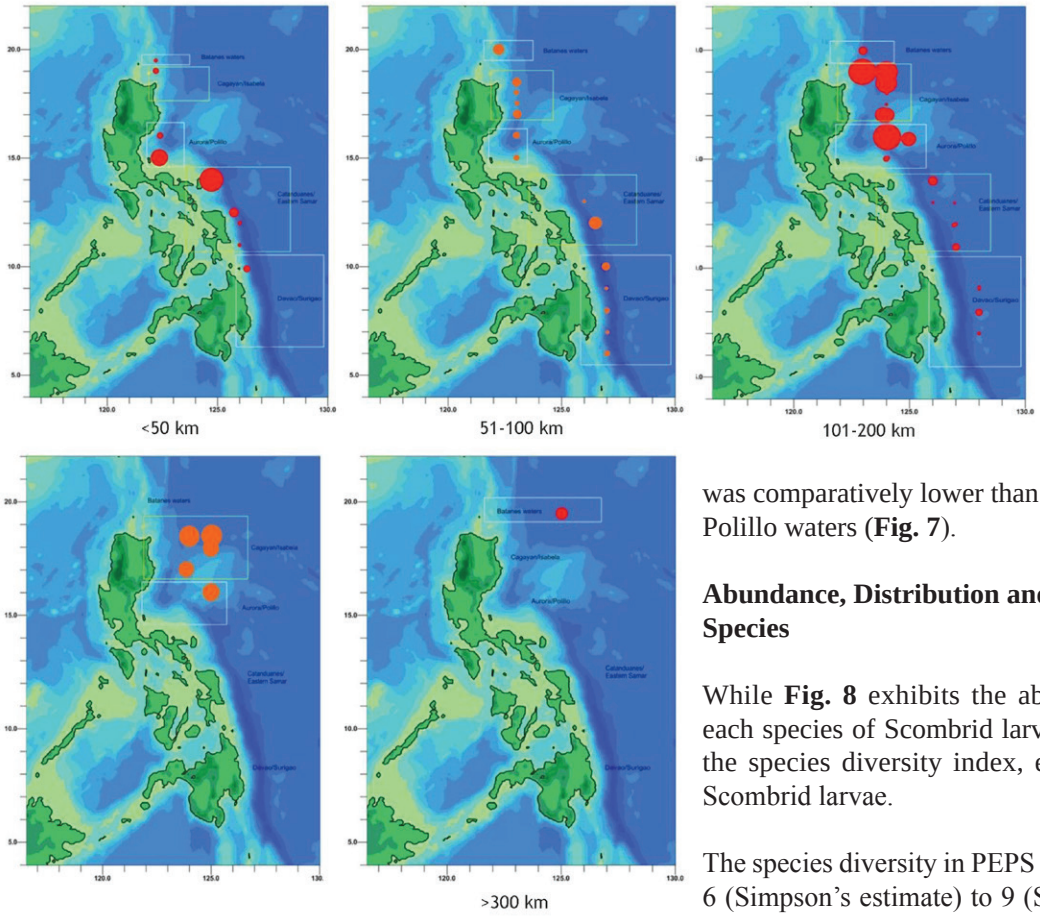


Fig. 5. Abundance and distribution of Scombrid larvae at various distances from shore *(Scale: 0.025 in dia = 10 larvae/1000 m³ of seawater; 0.250 in dia= 500 larvae/1000 m³ of seawater)*

relatively high density of larvae was observed in stations less than 50 km away from shore as well as in stations 101 to 200 km away from the shore, as indicated in the mean densities of Scombrid larvae at various distances from the shore (**Fig. 6**).

In terms of the abundance of tuna larvae by sampling zone, high mean densities were recorded along Aurora/Polillo waters at less than 50 km and 101-200 km away from nearest shore as well as in the Batanes waters from 51 to 100 km and greater than 300 km away from the shore, and across Cagayan/Isabela waters from 101 to 300 km from shore. Catanduanes/Eastern Samar and Davao/Surigao waters on the other hand, exhibited high concentration of larvae at less than 50 km distance from the shoreline but such abundance

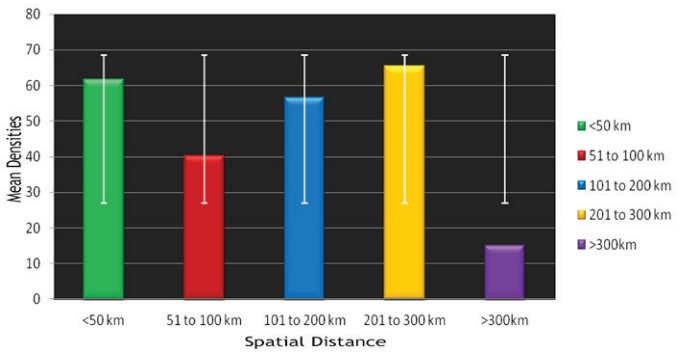


Fig. 6. Mean densities of Scombrid larvae at various distances from the shore

was comparatively lower than those observed in the Aurora/Polillo waters (**Fig. 7**).

Abundance, Distribution and Diversity of Scombrid Species

While **Fig. 8** exhibits the abundance and distribution of each species of Scombrid larvae in PEPS, **Fig. 9** illustrates the species diversity index, evenness and richness of the Scombrid larvae.

The species diversity in PEPS could be considered high with 6 (Simpson's estimate) to 9 (Shannon's estimate) dominant species from the 13 accounted species of Scombrids. Results of the analysis of the species diversity by area indicated high species diversity along Batanes and Cagayan/Isabela waters but low along Aurora/Polillo waters (**Fig. 10**). The Simpson's reciprocal index suggests 6 dominant species in Batanes waters and 5 along Cagayan/Isabela waters which is comparable with the Shannon's estimates of 6 dominant species for both areas.

The dominant species are: *Thunnus albacores* (yellowfin tuna), *Thunnus obesus* (big-eye tuna), *Thunnus alalunga* (albacore tuna), *Acanthocybium solandri* (wahoo), *Katsuwonus pelamis* (skipjack tuna), and *Auxis* spp. (bullet tuna) based on their relative abundance in the total samples. Aurora/Polillo waters had the lowest diversity index value because the collected larvae species on the area were dominated by 3 (Simpson's estimates) to 4 (Shannon's estimates) species only, namely: *Thunnus* spp., *Euthynnus affinis* (kawakawa), *Allothunnus* spp. (slender tuna), and *Thunnus obesus*.

An analysis of the samples obtained from the Aurora/Polillo waters which indicated low evenness value could also have contributed to the low diversity index. The relative abundance of Scombrid species per sampling zone is shown in **Fig. 11**. The slight discrepancy of the Shannon's estimates with that of Simpson's Index could be explained by Shannon's sensitivity to species richness and dependence on sample size because Simpson's Index although not dependent on the sample size

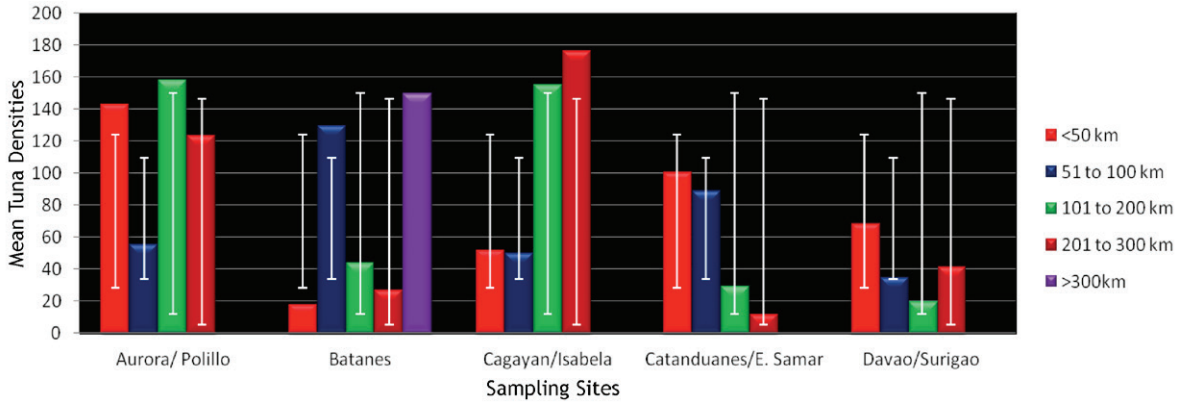


Fig. 7. Mean densities of tuna larvae at various sampling stations and distances from shore

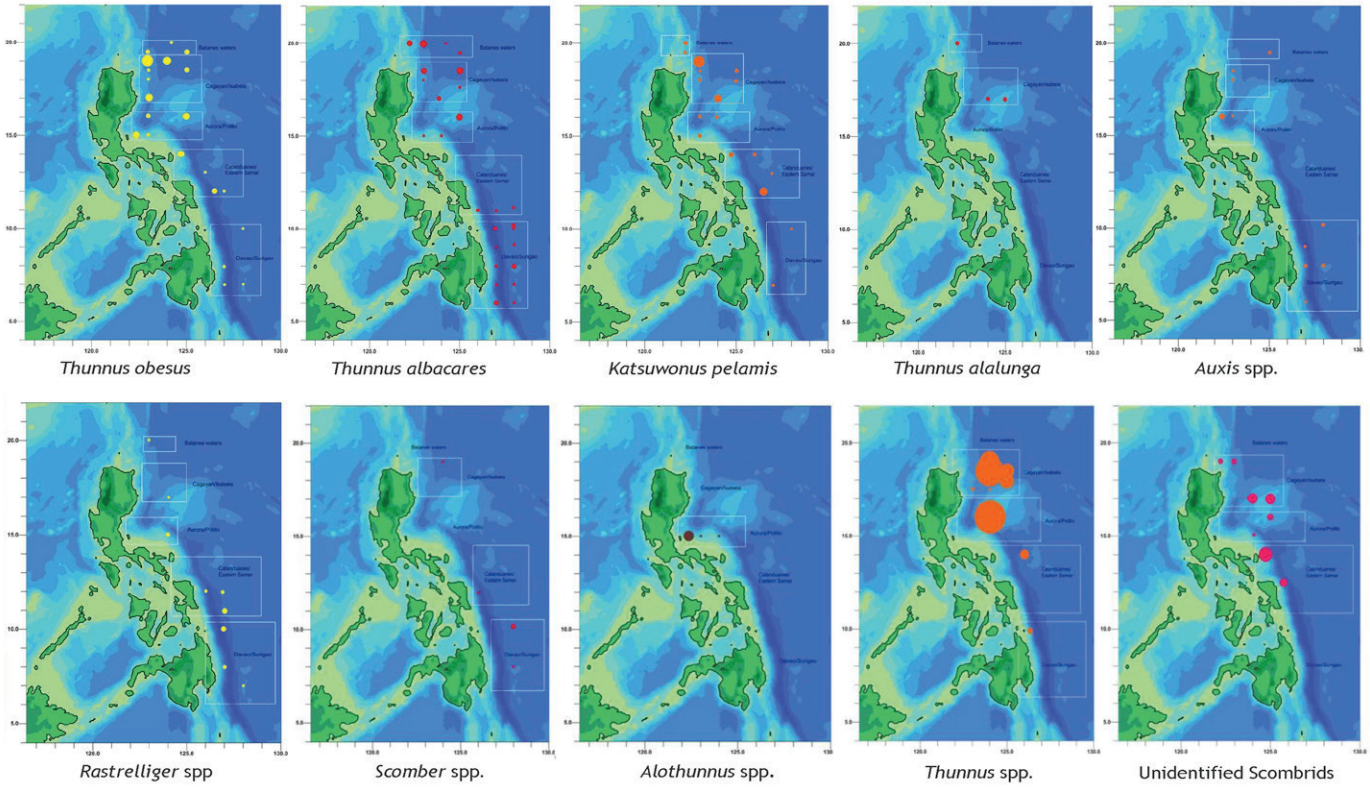


Fig. 8. Abundance and distribution of different species of Scombrid larvae in the Philippine Eastern Pacific Seaboard
(Scale: 0.025 in dia = 10 larvae/1000 m³ of seawater; 0.250 in dia= 500 larvae/1000 m³ of seawater)

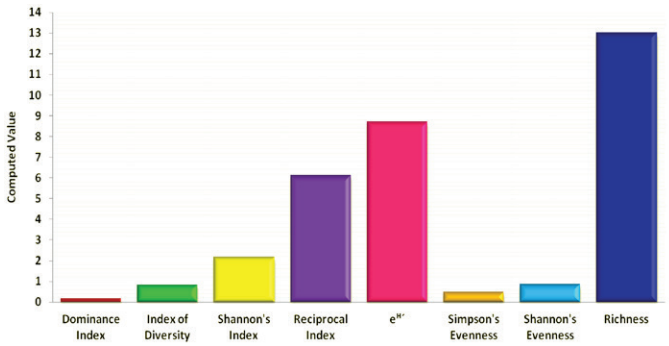


Fig. 9. Total species diversity, evenness and richness of Scombrid larvae in the Philippine Eastern Pacific Seaboard

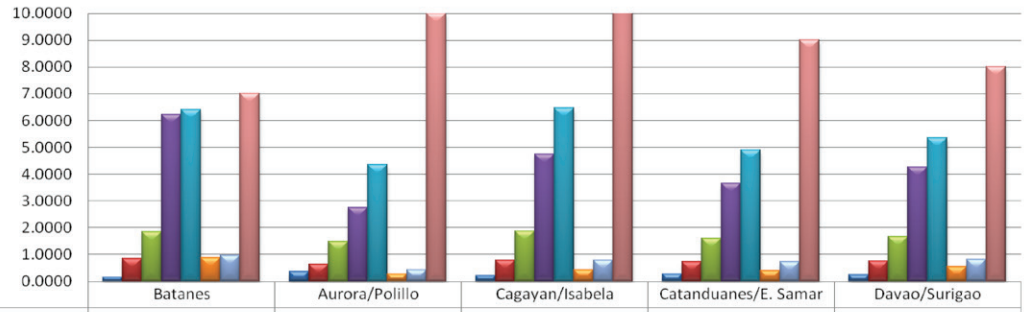
is somewhat sensitive to the evenness. Thus, the Shannon estimates of the dominant species appear higher compared with those of Simpson's (*i.e.* $e^{H'}$) and to the total number of species present per fishing ground as shown in **Fig. 10**).

Nonetheless, both indices showed significant relationships in the diversity estimates as shown in **Table 1**.

Table 1 also indicates the correlation of Shannon's and Simpson's Indices in terms of diversity estimates. All of the compared indices bring out positive relationships except Simpson's D and Shannon's Index which had negative relationship. This happened because the Simpson's D value implies high diversity as it approaches zero while the rest of the indices means otherwise.

Variation in Monthly Abundance

The abundance and distribution of Scombrid larvae in different months are indicated in **Fig. 12**. The sampling area for the month of April covered only the waters across Catanduanes/ Eastern Samar and Aurora/Polillo; while Aurora/Pollilo,



	Batanes	Aurora/Polillo	Cagayan/Isabela	Catanduanes/E. Samar	Davao/Surigao
Dominance Index (D)	0.1610	0.3652	0.2109	0.2730	0.2342
Index of Diversity (1-D)	0.8390	0.6348	0.7891	0.7270	0.7658
Shannon's Index (H')	1.9	1.5	1.9	1.6	1.7
Reciprocal Index (1/D)	6	3	5	4	4
$e^{H'}$	6	4	6	5	5
Simpson's Evenness	0.8872	0.2738	0.4310	0.4071	0.5338
Shannon's Evenness	0.9536	0.4374	0.7779	0.7221	0.8050
Number of Species present (richness)	7	10	11	9	8

Fig. 10. Species density of Scombrid larvae from various sampling stations in the Philippine Eastern Pacific Seaboard

Cagayan/Isabela and Batanes waters were covered in May and the whole Eastern Pacific Seaboard (except Aurora/Pollilo waters) during the month of June. The August sampling on the other hand, covered only the waters of Eastern Samar and Surigao. Comparative analysis per sampling station brought about high density of the Scombrids along Catanduanes/ Eastern Samar waters during the month of April; along Aurora/ Pollilo waters in May, and Cagayan/Isabela waters in June while in August the larvae tend to aggregate along the Davao/ Surigao waters (**Fig. 13**).

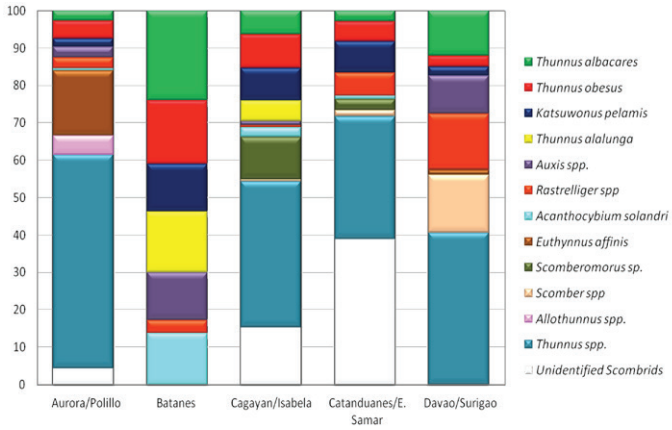


Fig. 11. Relative abundance (%) of various species of Scombrid larvae by sampling station

Table 1. Correlation values of Simpson's and Shannon's Indices

Indices Compared	Correlation Values
Simpson's Dominance Index (D) and Shannon's Index Correlation	-0.932234200
Simpson's Index of Diversity and Shannon's Index Correlation	0.932234200
Simpson's Reciprocal Index and $e^{H'}$ Correlation	0.901072446
Simpson's Evenness and Shannon's Evenness Correlation	0.867941819

On the total densities per month, Scombrid larvae were found to be more abundant in May with mean density of 65 larvae/1000 m³ of seawater but least in August with 36 larvae/1000 m³ of seawater (**Fig. 14**).

In terms of species diversity, the month of May had the most diverse species of Scombrid larvae compared with those during other sampling months and low in April as well as in June (**Fig. 15**). The relative abundance of Scombrid species per month is shown in **Fig. 16**.

Influence of Temperature

Temperature plays a major role in the spawning habit of most fishes, as adequate temperature is necessary for most fish eggs to hatch as well on the development of the appendages of the larvae. Unsuitable temperature could mar the hatching of fish eggs and is detrimental to development of the larvae (FAO, 1994; Margulies *et al*., 2007).

When the mean temperatures of the sampling stations from 1-150 m were compared to the total densities of the Scombrid larvae, results showed that the larvae were more abundant in stations with mean temperature of 27°C and low at stations with 23°C mean temperature. In the same way, relatively high density was noted at stations with 26°C mean temperature (**Fig. 17**).

The relative abundance of each species of Scombrids at various temperature ranges is shown in **Fig. 18**.

Food Availability

The influence of food availability based on chlorophyll-*a* concentration was assessed to determine its possible effect on the abundance and distribution of the Scombrid larvae. Specifically, the mean chlorophyll-*a* concentration from

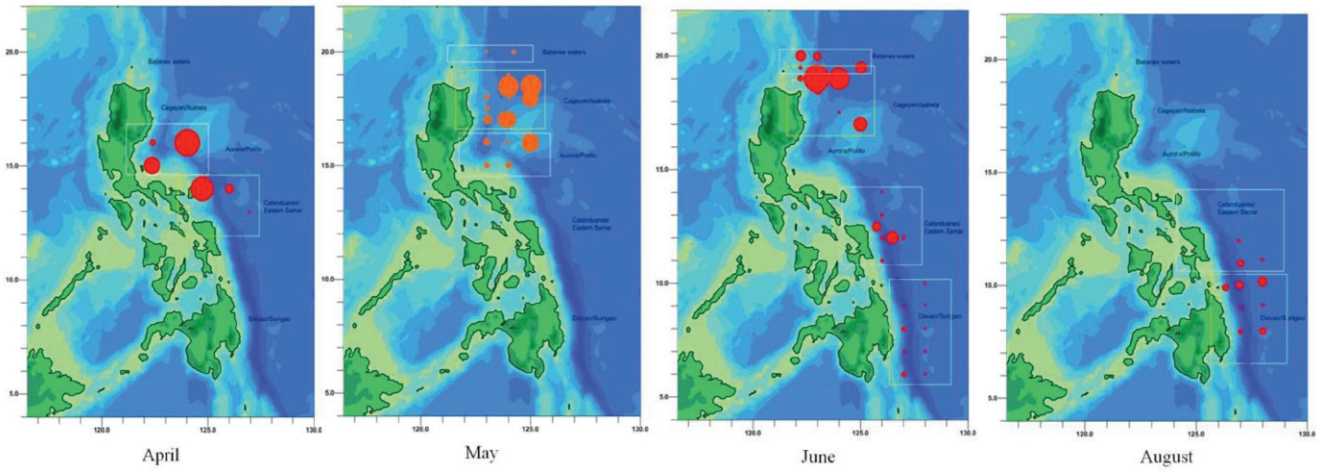


Fig. 12. Abundance and distribution of different species of Scombrid larvae in different months
(Scale: 0.025 in dia = 10 larvae/1000 m³ of seawater; 0.250 in dia= 500 larvae/1000 m³ of seawater)

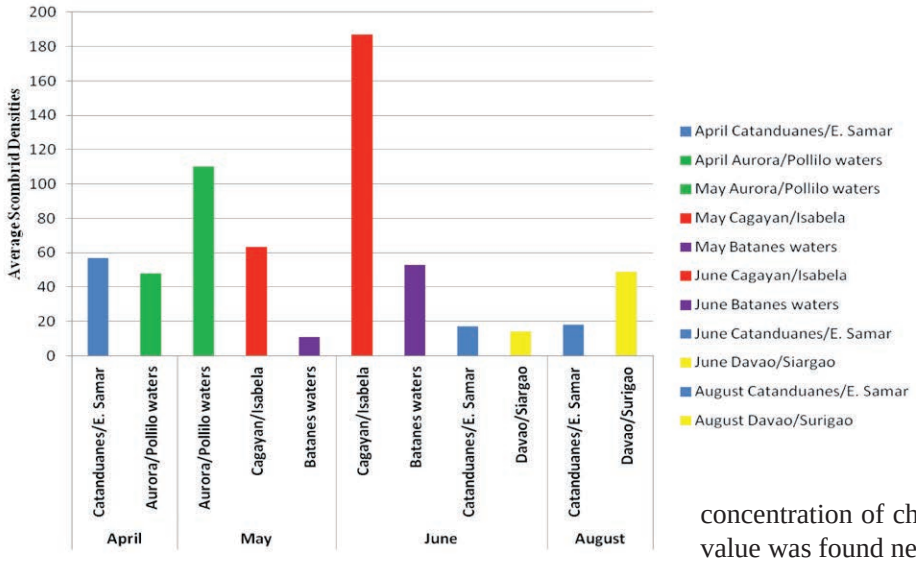


Fig. 13. Monthly variation of the densities of Scombrid larvae from different sampling sites

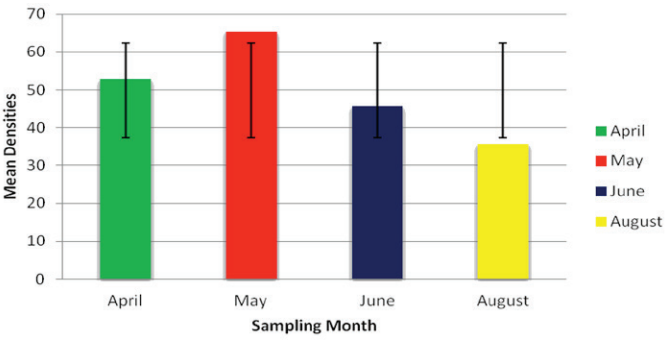


Fig. 14. Monthly variation of the densities of Scombrid larvae

1-150 m was used to determine if the availability of food (phytoplankton) in a certain station at said depth range affects the density of tuna larvae. Results of the analysis showed that the tuna larvae tend to aggregate at stations with mean chlorophyll-*a* concentration of 0.2 µg/L, 0.3 µg/L and 0.8 µg/L. Densities of the tuna larvae also tend to decrease as the concentration of chlorophyll-*a* increases but the correlation value was found negligible (**Fig. 19** and **Fig. 20**).

Sampling Time

Sampling time was also considered for its importance in finding out the diel migration patterns of oceanic organisms. Results indicated that afternoon sampling gathered more Scombrid larvae than evening and morning samplings but the mean density of the Scombrid larvae in the evening sampling slightly differs from the abundance of the Scombrid larvae collected during the afternoon sampling (**Fig. 21**).

Conclusion and Recommendations for Future Works

From the results of the study, it can be concluded that the total abundance and distribution of Scombrid larvae in the Philippine Eastern Pacific Seaboard is affected by temperature, sampling area, sampling season, sampling time, and spatial distance. Food availability was however, found to be a non-significant factor affecting the abundance of Scombrid larvae although species diversity was influenced by the sampling area and sampling season.

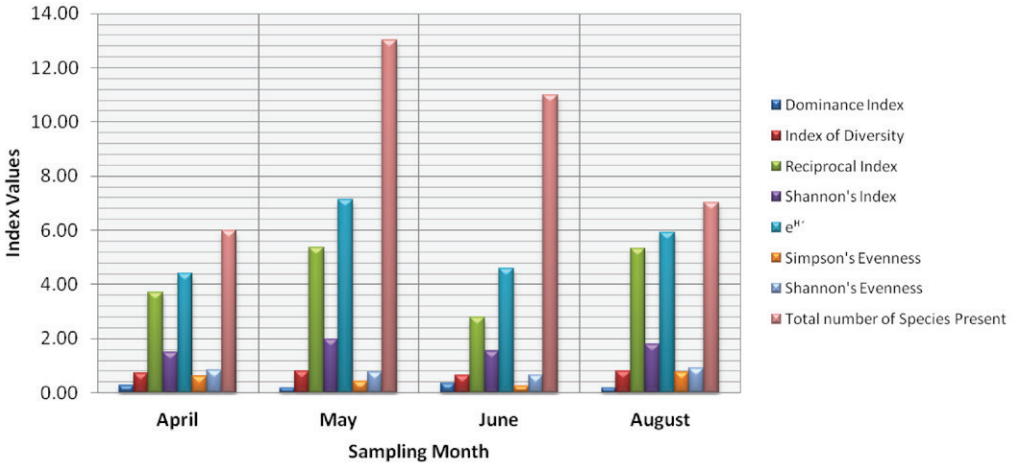


Fig. 15. Species diversity index of Scombrid larvae by sampling month

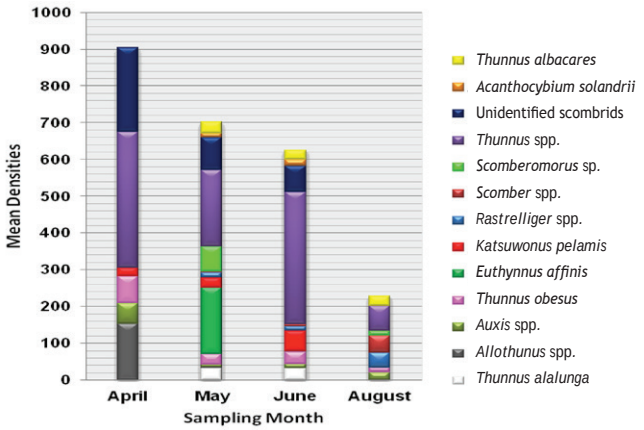


Fig. 16. Relative abundance (%) of species of Scombrid larvae by sampling month

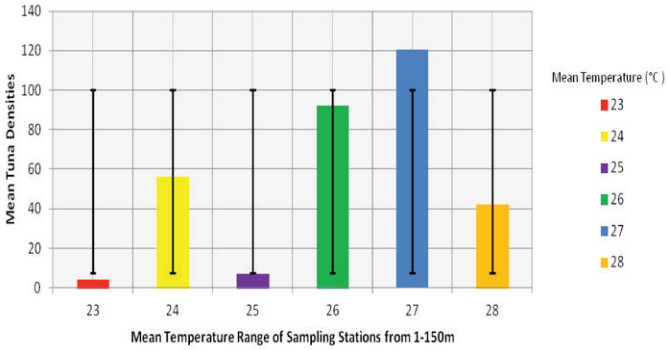


Fig. 17. Mean densities of Scombrid larvae in various temperature ranges

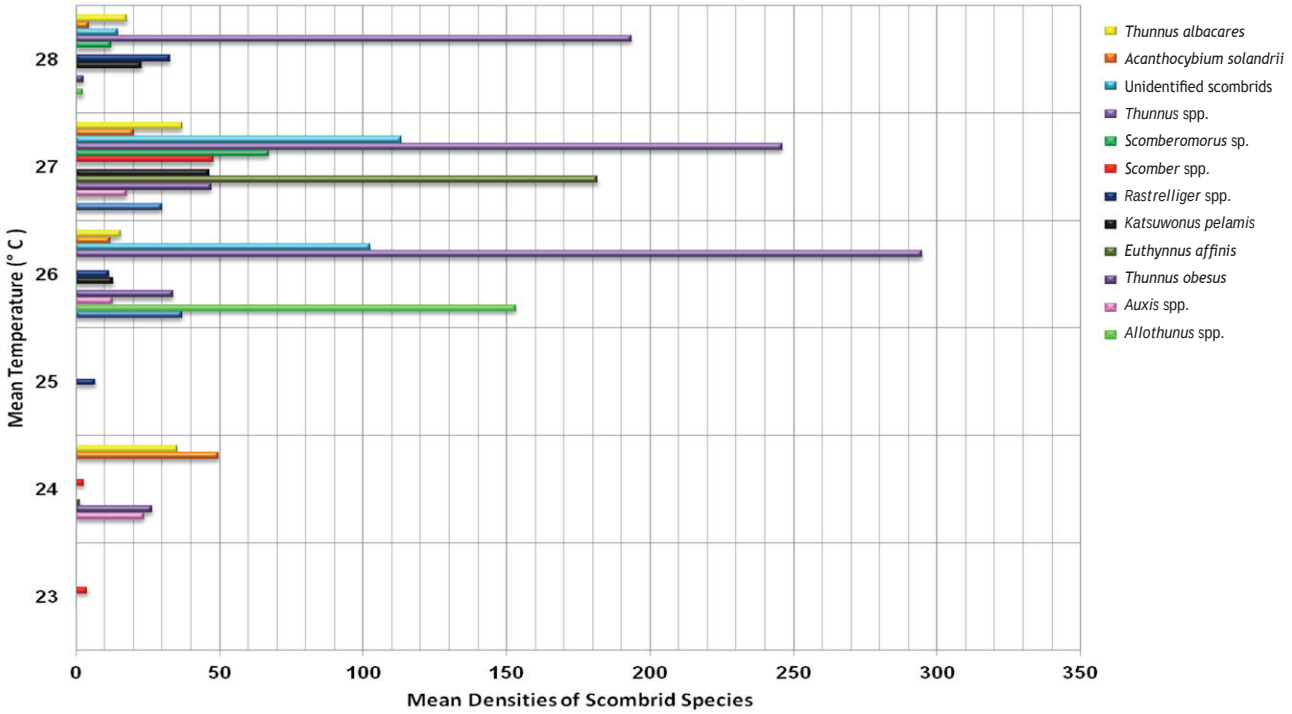


Fig. 18. Species of Scombrid larvae in PEPS corresponding to various temperature zones

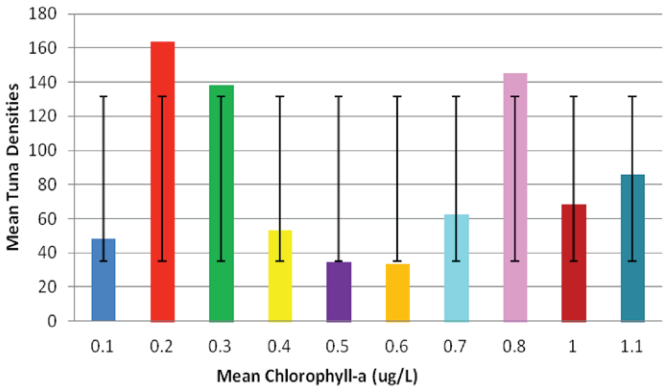


Fig. 19. Mean densities of tuna larvae at various ranges of mean chlorophyll-*a* concentrations

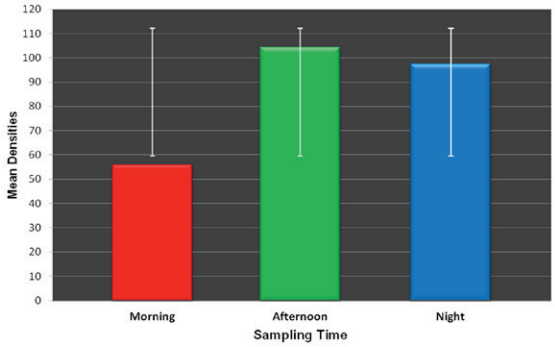


Fig. 21. Mean densities of Scombrid larvae at different sampling times

Results of studies conducted on the variability of water current in the Philippine Eastern Pacific Seaboard could be used to correlate with the results of this study in order to assess the possible relationship between current variability and larvae retention sites in the PEPS. Statistics on catch landings of tuna and tuna-like species should also be used to determine whether the dominant species of the Scombrid larvae observed in a particular sampling station of this case study coincides with the most common tuna and tuna-like species caught from the same area. Transects along the Davao/Surigao waters should be expanded in future oceanographic studies in the area for better comparison of spatial densities of the Scombrid larvae. Studies on seasonal variability of Scombrid larvae in the Philippine Pacific Seaboard should be pursued to create a more comprehensive profile of the larvae's abundance and distribution at different seasons. Moreover, there is a need to widen the sampling area for the seasonal variability study and increase sampling stations to avoid possible sampling bias. Molecular analysis should also be carried out for the unidentified species of Scombrid larvae to confidently classify them into species level.

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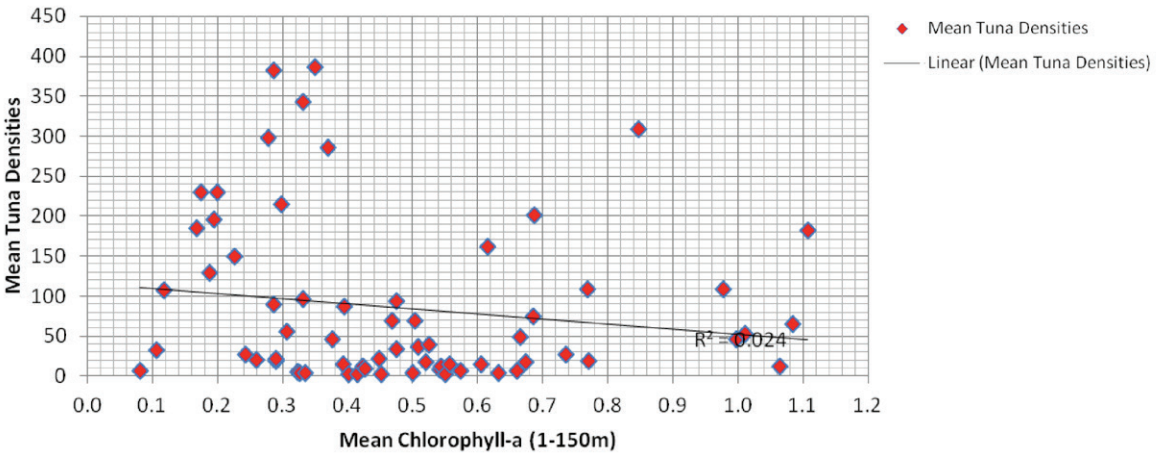

Fig. 20. Correlation between densities of tuna larvae and mean chlorophyll-*a* concentrations

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Estimating the Maximum Sustainable Yield for Coastal Fisheries: A Case Study in Nui Thanh District, Quang Nam Province, Viet Nam

To Van Phuong, Phan Trong Huyen and *Kari S. Fridriksson*

Many government reports recently indicate that the coastal fisheries of Viet Nam have experienced overfishing and overcapacity. Although few fishery management studies had been conducted to address the situation, no quantitative research had been carried out, possibly because of too much aggregation of data considering the different types of fishing operations that catch various species from different fishing grounds. Using the currently available data with some new data collected, an analysis was conducted to estimate the maximum sustainable yield (MSY) and the level of fishing effort in the coastal fisheries of Nui Thanh District in Quang Nam Province, Viet Nam. The ultimate goal is to determine the most appropriate economical fisheries management policy for the sustainability of coastal fisheries in Quang Nam Province in particular and the whole of Viet Nam in general.

Coastal fisheries in Nui Thanh District, Quang Nam Province of Viet Nam (**Fig. 1**) is considered small-scale but plays very important role in the economic development of the Province and livelihoods of fishers, being one of the ten most important fisheries in Viet Nam as is evidenced by the presence of 4,157 fishing vessels with total capacity of more than 171,358 horse power (**Fig. 2**). With a coastline of 125 km, Quang Nam Province embraces an exclusive economic zone of more than 40,000 km^2, which is abundant in marine fishery resources with high species diversity (Luong, 2014).

Marine capture fisheries in Viet Nam could not be readily classified into either small-scale or industrial, as there are many factors such as hull length, engine power, distance from shore, depth of fishing grounds exploited, and gear deployed, that should be considered in defining the types of fisheries. However, the country's marine fisheries could be generally considered small-scale due to the fact that these are operating in near-shore waters, and as a consequence, near-shore fishery resources are overfished (Pomeroy, 2009). Reports have indicated that in Nui Thanh District, the number of fishing vessels with motor engines increased sharply from 975 in 2003 to 1,527 in 2013, and now accounts for more than 58% of the total fishing vessels in Quang Nam Province. Most of the fishing vessels in Nui Thanh District (86%) are small with less than 90 horse power (HP) engine capacity each.

The main fisheries operating in Quang Nam Province include trawl (**Fig. 3**), purse seine, gillnet, driftnet, longline, and

Fig. 1. Map of Viet Nam showing Quang Nam Province

diving, using about 871 small fishing vessels in coastal areas within 15 nautical miles from the shore. Recent reports have indicated that the fishery resources in the waters of Nui Thanh District are already in severe state of exploitation. Vessels operating in the coastal areas use variety of illegal fishing gears undermining the future increases in biomass, *e.g.* using small mesh-sized fishing nets in catching juvenile fishes that affect not only the quality of catch but also future spawning, using electrical impulses and explosives that tend to increase fish wastage. Moreover, banned trawls with powerful engines still operate near the shore negatively impacting on the benthic ecosystem (Hung, 2009; Quoc, 2013; Du, 2015).

As a result, the fishery resources of Nui Thanh are currently being overexploited (Luong, 2014; Agriculture Department of Nui Thanh, 2014), considering that too many fishing vessels are operating with no explicit regulations and ways to reduce fishing effort. Furthermore, conflicts on the utilization of fishing grounds among fishers had been rising because of decreasing catch. Fishers believed that the current annual catch had decreased by about 30-40% compared with that of 5 years ago (Luong, 2014). Reduced catch has led to diminishing benefits from fishing activities and reduced quality of life of fishers and their families. The central and lower levels of the Government, such as the provincial and

Fig. 2. Small-scale fishing boats in Nui Thanh District, Quang Nam Province

Fig. 3. A trawl fishing vessel anchored at Tam Quang Port, Quang Nam Province

district levels (Agriculture Department of Nui Thanh, 2014; Gioi, 2014) had recognized the problems and attempted to carry out studies on fisheries management systems, but not on the maximum sustainable yield (MSY) as well as on the fishing effort level at such estimated MSYs. Although the issues might have been identified, these could not be supported by any analysis due to insufficient data, as there had been no estimates of the total allowable catch and no analysis of reasonable fishing effort level in different fishing grounds and species. Thus, local authorities do not have any sound basis for designing and implementing the appropriate management measures, even if previous reports contain few proposals for the conduct of quantitative research on the improvement of policies, planning or management of this valuable resource. The main problem is insufficient data for assessing the coastal marine resources and for estimating the fishing effort. In order to address the aforementioned problems, new survey data had been compiled with the intention of coming up with information on the number and kind of fishing vessels operating in regulated near-shore areas; the MSY for different fishing gear; level of fishing effort compatible with the MSYs; and options for policy-makers to consider in order to achieve sustainable fisheries.

Compilation of Necessary Data

In order to compile the necessary data, a study was carried out from 2012 to 2014 in Nui Thanh District of Quang Nam Province, Viet Nam, defined within the line from point 7' to point 8' regulated in Decree no.33/ND-CP (approved by the Prime Minister in 2010 regulating the fishing activities by individual or company in Viet Nam waters). The study included estimation of the fishing effort, catch and catch per unit effort (CPUE) of each fishing gear in 2011-2014. Using the Schaefer Surplus Production Model 1, the MSY was determined and the level of fishing effort corresponding to such MSYs was also estimated for each main fishery. Such information would be useful for the development of some feasible fisheries policies by local policy-makers. During the study, data were obtained from secondary as well as primary sources. The secondary sources included published papers and government reports on Nui Thanh fisheries, where relevant information were used to infer and define the status of fisheries, including socio-economic information and fishing vessels. Models were then developed based on the information from those papers, books and conference reports, and the catch, fishing effort, and CPUE among others, were estimated. For the primary data, surveys were conducted to collect sample data on 110 vessels, chosen through stratification by classification in order to represent the population. The data compiled was used to assess the status and dynamics of fishing efforts and catch from 2011 to 2014. In addition, relevant information was also obtained through interviews with authorities, fishers, and specialists conducted by e-mail and through telephone.

Identification of Coastal Fishing Vessels

Four steps were used to define the types of fishing vessels operating in specific areas (**Box 1**). As a result, the list of coastal fishing vessels operating in the study area from 2011 to 2014 had been established and appropriately classified.

Estimation of Catch Landing

Estimating the catch by gear categories makes use of the FAO Guidelines (FAO, 2002), and was carried out after the coastal fishing effort had been determined using the Schaefer Logistic Model.

Productivity (CPUE)

The average catch per unit of effort (CPUE) of each fishing gear group was estimated using formula (1):

$$\overline{CPUE} = \frac{1}{n}\sum_{i=1}^{n} CPUE_i \quad \text{..... (1)}$$

where: ($\overline{CPUE}$) is the average CPUE (kg/fishing day); CPUEi is catch per unit effort of fishing vessel i; n is the number of fishing gear groups in the study area (i = 1-6)

Catch of each fishing gear

The catch of each fishing gear was determined by using equation (2)

$$C_i = \overline{CPUE_i} \cdot A_i \cdot BAC_i \cdot F_i \quad \text{..... (2)}$$

Box 1. Steps in identifying coastal fishing vessels (Phuong, 2015)

Step 1: A list of all fishing vessels with engine power lower than 20 HP was drawn from Nui Thanh District Agriculture Department, and those above 20 HP from the Department of Fishing and Marine Resource Protection in Quang Nam Province. This resulted in the availability of the **Initial List of Vessels (I)**.

Step 2: Based on the above list (**I**), some vessels were excluded, *i.e.* fisheries service vessels, oceanic squid longline vessels, purse-seine with high engine power defined by the Research Institute for Marine Fisheries (RIMF, 2007); syndication of boats, production teams at sea, such as: Paracel Islands Union and Spratley Islands Union where vessels always fish offshore and operate on long cruises; and fishing vessels that are not operating at study area based on the information from local fisheries authorities such as the number of days per fishing trip, the number of crew per fishing vessel. The output was the **Preliminary List of Vessels (II)**.

Step 3: In order to verify the vessels in **II**, probability survey questionnaires were used to determine the fishing area of given fishing vessels. Vessels that operate beyond 15 nautical miles were removed, where only fishing vessels in **II** as coastal fishing vessels were kept, other vessels were excluded. Field surveys were conducted at sea where the information obtained included a random sample of registered number of vessels for each fishing trip. This information was used to check and confirm the list of coastal vessels. The output was the **Final List of Coastal Fishing Vessels**.

Step 4: In determining the dynamics of fishing vessels overtime (2011-2014), the detailed information on each fishing vessel in **II** was compiled, such as the year built, year upgraded and the year of operation with registration. In addition, a qualitative assessment from local fishery managers and leaders of local communities was also obtained. The output was the **List of Coastal Fishing Vessels** operating in the study area from 2011 to 2014.

where: C_i is the catch of fishing gear group i (metric tons); $\overline{CPUE_i}$ is average catch per unit of effort in fishing group i (kg/fishing day); A_i is active days survey factor of fishing gear group i indicating the total number of potentially operating days of fishing vessels; BAC_i is boat activity coefficient expressing the probability that any vessel will be active on any given day of group i; F_i is the number of fishing vessels within group i that are estimated to fish in near-shore areas.

The Surplus Production Model was used to estimate the maximum sustainable catch (MSY) and the corresponding effort level (f_{MSY}). The following input data were required:

f_i is fishing effort in year i, where i= 1,2,3…,n
Y_i is yield in year i, where i= 1,2,3….,n
$\frac{Y}{f}$ is yield (catch in weight) per unit of fishing effort in year t.

According to Schaefer (1954) and Sparre (1992), $\frac{Y}{f}$ is a function of the effort f, computed as follows:

$$\frac{Y}{f} = \frac{Y_i}{f_i} = a + b \cdot f \text{ (where } f_i \leq -\frac{a}{b}) \quad \ldots\ldots\ldots (3)$$

Where the intercept "a" is the $\frac{Y}{f}$ value obtained just after the first boat fishes the stock for the first time. The intercept then must be positive. The slope "b" must be negative if the catch per unit of fishing effort $\frac{Y}{f}$ decreases for increasing effort f. Therefore, $-\frac{a}{b}$ is positive and $\frac{Y}{f}$ is zero for f= $-\frac{a}{b}$ (Sparre,1998). Here, equation (3) is used to determine MSY, f_{MSY}. The Schaefer model, is a parabola, which has its maximum value of Y_i, the MSY level, at an effort level:

$$f_{MSY} = \frac{-a}{2 \cdot b} \text{ ; and the corresponding yield } Y_{MSY} = \frac{-a^2}{4 \cdot b}$$

Results

The fishing effort in the coastal areas of Nui Thanh District was determined based mainly on small vessels with engine capacity of less than 45 HP (**Fig. 4**). In 2014, gillnet was the main fishery with 343 boats (39%), while driftnet and purse seine were operated with the least number of fishing boats.

Active Days Survey Factor (A)

The study indicated that the Active Days Survey factor (**Table 1**) had about 15 days less in January and February because of the celebration of the Vietnamese Lunar New Year, and also in November and December due to bad weather.

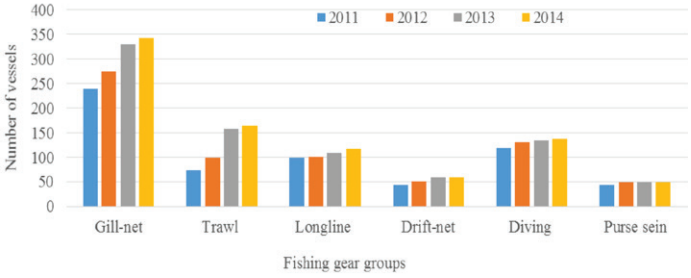

Fig. 4. Number of boats by fishing gear from 2011 to 2014

Table 1. The Active Days Survey of different fishing methods (days)

Fishing method	Months in a year (year 2014)												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
Gillnet	17	17	26	25	26	25	26	25	21	21	20	23	**272**
Trawl	15	15	31	30	31	30	31	30	26	26	20	20	**305**
Longline	15	15	24	24	24	24	24	23	26	26	20	20	**265**
Driftnet	15	15	24	23	24	23	24	22	19	19	18	21	**247**
Diving	10	15	31	30	31	30	31	23	23	15	15	10	**264**
Purse seine	15	15	24	23	24	23	24	22	19	19	18	21	**247**

Table 2. Boat Activity Coefficient (BAC) by fishing gears

Fishing method	Months in a year (year 2014)												Average
	1	2	3	4	5	6	7	8	9	10	11	12	
Gillnet	0.60	0.50	0.60	0.67	0.80	0.80	0.70	0.93	0.70	0.60	0.60	0.67	**0.68**
Trawl	0.33	0.47	0.87	0.80	0.80	0.87	0.80	0.80	0.67	0.53	0.60	0.53	**0.67**
Longline	0.42	0.50	0.70	0.82	0.83	0.80	0.83	0.88	0.75	0.70	0.60	0.75	**0.71**
Driftnet	0.60	0.47	0.89	0.90	0.93	0.89	0.80	0.88	0.43	0.60	0.50	0.63	**0.71**
Diving	0.60	0.80	0.90	0.80	0.87	0.93	0.93	0.80	0.73	0.67	0.53	0.60	**0.76**
Purse seine	0.57	0.75	0.80	0.73	0.86	0.80	0.90	0.73	0.70	0.50	0.56	0.60	**0.71**

Table 3. Actual fishing days (days)

Fishing method	Months in a year (year 2014)												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
Gillnet	10	9	16	17	21	20	18	23	15	13	12	15	**188**
Trawl	5	7	27	24	25	26	25	24	17	14	12	11	**216**
Longline	6	8	17	20	20	19	20	20	20	18	12	15	**194**
Driftnet	9	7	21	21	22	20	19	19	8	11	9	13	**181**
Diving	6	12	28	24	27	28	29	18	17	10	8	6	**213**
Purse seine	9	11	19	17	21	18	22	16	13	10	10	13	**178**

Boat Activity Coefficient

Results of the survey of Boat Activity Coefficient (BAC) of all fishing gear groups in the coastal areas of Nui Thanh are presented as **Table 2**. The general average BAC is about 0.71

Actual Fishing Days

Using A and BAC above, the actual fishing days are computed as AxBAC, the results of which are shown in **Table 3**.

Catch per Unit of Effort (CPUE)

The research results showed that the CPUE of each fishing gear are decreasing overtime as shown in **Table 4**.

As shown in **Table 4**, the productivity of each fishery is decreasing overtime. The productivity in 2014 had reduced at 44.00% compared with that of 2011. This shows that the coastal fishery resources of Nui Thanh are currently over-fished and the fisheries is experiencing over-capacity.

Table 4. Fishing productivity of each fishing gear overtime (kg/fishing day)

Fishing method	Year			
	2011	2012	2013	2014
Gillnet	48.10	44.04	37.20	31.03
Trawl	208.82	163.97	137.06	119.12
Longline	40.07	30.05	24.04	20.03
Drift-net	78.86	56.33	45.34	39.43
Diving	25.48	19.11	15.29	12.74
Purse seine	70.67	58.20	49.89	41.57
Average	**78.68**	**61.95**	**51.47**	**43.99**
Reduced rate compared with that of 2011 (%)		**21.00**	**35.00**	**44.00**

Estimation of Coastal Catch

Using the data in **Table 4**, the catch of each fishing gear in metric tons (MT) could be estimated, the results of which are shown in **Table 5**.

Table 5. Catch of all coastal fishery groups (in MT)

Fishing method	Year			
	2011	2012	2013	2014
Gillnet	2,140	2,242	2,273	1,970
Trawl	4,067	3,362	4,412	4,005
Longline	759	575	501	448
Driftnet	621	503	476	414
Diving	611	505	413	352
Purse seine	556	498	427	356
Total	**8,754**	**7,684**	**8,501**	**7,545**

Table 5 shows that the catch of trawl accounted for the highest proportion at 53% followed by gillnet at about 26% of the total catch.

Estimation of MSY and f_{MSY}

Based on the research results on catch and fishing effort in each fishery, the CPUE was estimated to be used as basis for modelling, in order to obtain the MSY and f_{MSY} of each fishery.

Gillnet and Trawl Fisheries

The maximum sustainable yield (MSY) and level of fishing effort of gillnet fishery at the MSY are 2,209 MT and 279 vessels, respectively. The corresponding values for trawl fishery are 4,217 MT and 146 vessels, respectively. The Schaefer models for each fishery are presented in **Fig. 5** and **Fig. 6**.

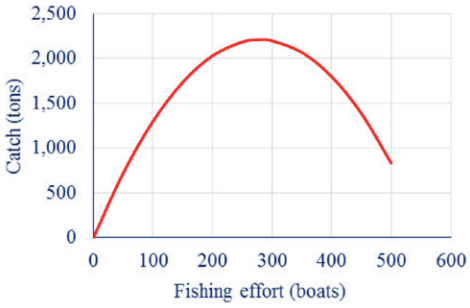

Fig. 5. Schaefer model for gillnet fishery

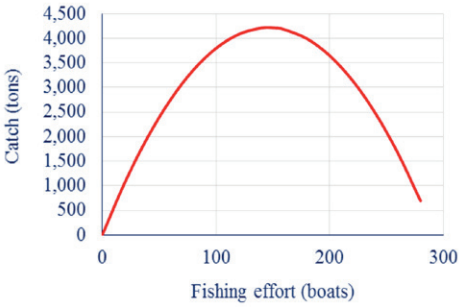

Fig. 6. Schaefer model for trawl fishery

Table 6. Estimation of MSY and f_{MSY} for coastal fisheries of Nui Thanh District

Fishery	Maximum sustainable level		Effort in 2014 (boats)	Reduced Effort (boats)
	Yield (metrictons)	Effort (boats)		
Gillnet	2,209	279	188	63
Trawl	4.217	140	216	11
Longline	831	69	194	49
Driftnet	609	39	181	21
Diving	853	78	213	59
Purse seine	780	29	178	20
Total	9,500	642	871	229

Longline and Driftnet Fisheries

The MSY and level of fishing effort of longline fishery at the MSY are 831 MT and 69 vessels, respectively. The corresponding values for driftnet fishery are 609 MT and 39 vessels, respectively. The Schaefer models for each fishery are presented in **Fig. 7** and **Fig. 8**.

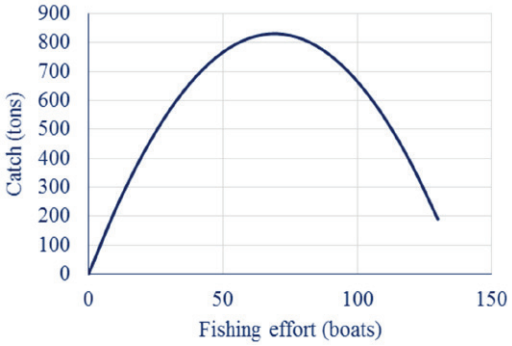

Fig. 7. Schaefer model for longline fishery

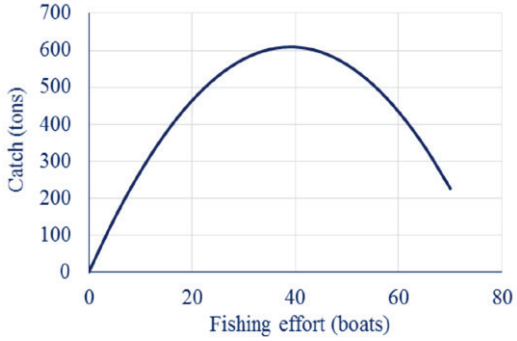

Fig. 8. Schaefer model for driftnet fishery

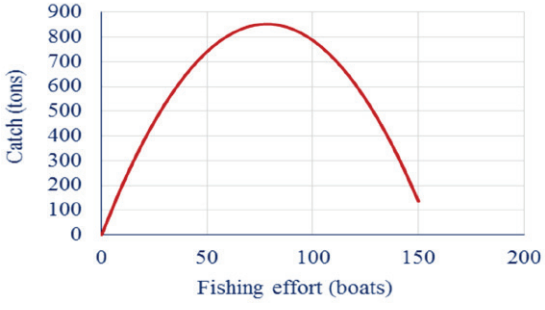

Fig. 9. Schaefer model for diving fishery

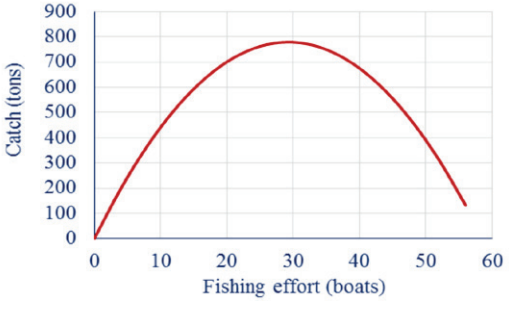

Fig. 10. Schaefer model for purse seine fishery

Diving and Purse Seine Fisheries

For diving fishery, MSY was estimated at 853 MT and fishing level at MSY at 78 boats. In purse seine fisheries, the MSY and f_{MSY} values were 780 MT and 29 boats, respectively. The values of the Schaefer model for these fisheries are shown in **Fig. 9** and **Fig. 10**.

To summarize, the maximum sustainable yield and the fishing level at MSY (f_{MSY}) for the coastal fisheries of Nui Thanh District are presented in **Table 6**. The maximum sustainable levels in **Table 6** seem to suggest that fishing effort should be reduced and as such the suggested reduced effort are also shown in the table.

The results have indicated that the coastal fisheries of Nui Thanh are characterised by overfishing and overcapacity. Due to overcapacity, the catch and especially the CPUE had dropped by approximately 30-40% compared with those of five (5) years ago. It should also be noted that gillnet and trawl fisheries accounted for high catch and effort at about 67%.

Conclusion and Recommendations

In order to reasonably utilize the marine coastal fishery resources in Nui Thanh District, it is necessary to reduce the current (2014) fleet by 229 fishing vessels. As indicated in **Table 6**, the MSY is estimated at 9,500 MT and effort level at MSY is expected at 642 boats. The results also show that the current stock resource is being overfished by around 26.0% due to overcapacity. Specifically, the current fishing effort exceeds the f_{MSY} by 35.7%. The above results could be used in improving the fisheries policy management regime in the District, and ultimately improving the living standards of its residents. Improvements in coastal fisheries of Nui Thanh District could also serve as useful example for fisheries authorities in other districts of the country.

Territorial User Rights in Fishing (TURFs) associated with Individual Quota (IQ) or Individual Transferable Quota scheme (ITQs) had been introduced in many fisheries with good results. According to Arnason (2015a), in small-scale or artisanal fisheries, quota restrictions could be difficult to enforce on an individual fishers basis, thus, community fishing rights may be the best alternative way. Specifically, organizing fishers into groups with community ITQs and with some TURFs rights may be practical and an efficient way to proceed (Arnason, 2009; Arnasaon, 2015b). These could offer other means of controlling the fishing effort by making fishers within a specific community behave as if property rights for a fishing ground exist. When the fishers access to or use the coastal area that is restricted to a small group within communities, the community therefore can determine how to harvest fish from the fishing ground and to whom the fish is allocated.

Due to time and funding limitations, this study analyzed only a few years' fisheries data. It would be useful if the fisheries data had not been disaggregated into coastal and offshore fisheries. More detailed and comprehensive research studies need to be conducted to fix the Schaefer model because more fisheries data could lead to better estimation by the model.

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Boosting National Mechanisms to Combat IUU Fishing: Dynamism of the Southeast Asian Fisheries Sector

Abdul Razak Latun, Mazalina Ali, Mohd Tamimi Ali Ahmad, and *Masaya Katoh*

Fishing activities that do not comply with national, regional or international fisheries conservation and management legislations or measures comprise illegal, unregulated and unreported (IUU) fishing (Agnew & Barnes, 2004). IUU fishing is a complex scheme affecting many stakeholders from individual artisanal fishers in national waters to fishing fleets in the Exclusive Economic Zones (EEZs) and the high seas, up to the fish processors and fisheries managers in developed and developing countries. Efforts have been made by international and regional organizations in developing and promoting measures that would combat IUU fishing. The EC Regulation 1005/2008 to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (or the EC IUU Regulation) adopted on the 29 September 2008 and entered into force on 1 January 2010, displays the seriousness of the European Union (EU) to crack down on IUU fishing problems worldwide. Adoption of the EC IUU Regulation by global fisheries markets demonstrates the significance of addressing IUU concerns and evaluating the efficacy of the EC IUU Regulation which was based primarily on the FAO International Plan of Action adopted in 2001 to prevent, deter and eliminate IUU fishing. In spite of all such efforts, the international community has not succeeded in reducing the scope of IUU fishing activities in the world. The issue has even bloated considering that a wider range of species is now being affected by IUU fishing activities in all oceans throughout the world. This critical situation is mainly brought about by IUU fishing operators who continue to find new markets and circumvent current control systems by insufficiently adapting them to the inherent complexity of trade flows. Considering that IUU fishing practices have earned approximately Euro 10.0 billion or USD 15.0 billion a year worldwide, IUU fishing is therefore the second largest dollar earner from trading of fish and fishery products in the world.

The ASEAN Member States (AMSs) comprise among the largest exporters of fish and fishery products to the European Union (EU). Thus, the obligatory implementation of EC Regulation 1005/2008 or EC IUU Regulation must have greatly affected, one way or another the trading of fish and fishery products from the AMSs. Nonetheless, the AMSs continue to implement measures to combat IUU fishing and mitigate the impacts of the EC IUU Regulation by enhancing their corresponding national mechanisms. Collectively, the AMSs have been developing and implementing measures through vessels registration, gear licensing, and use of log books and log sheets, among others. In addition, the AMSs continue to enhance the awareness and cooperation of fishers, particularly on the conservation of fishery resources, good management of landing at fishing ports, and proper handling of fish as raw materials for the processing industry. Many AMSs recognize the relevance of the EC IUU Regulation in Southeast Asia as the Regulation influences the enhancement and/or enforcement of relevant laws and regulations; improved monitoring, control and surveillance; enhanced the roles of governments in fishery resources management; and ultimately, boosted economic returns to fishers. Nevertheless, many countries are still dealing with the negative impacts emanating from the adoption of the EC IUU Regulation due to inadequate awareness of some policy makers in the region on the consequences of IUU fishing as it is affecting the sustainable development of the region's fisheries. During the Regional Core Experts Meeting organized by SEAFDEC in October 2013, a questionnaire survey was carried out by the SEAFDEC Marine Fishery Resources Development and Management Department (MFRDMD) to compile the positive and negative impacts of adopting the EC IUU Regulation in Southeast Asia (SEAFDEC/MFRDMD, 2013). The inputs provided by the countries to the questionnaire survey are summarized in this article.

Fishing Vessel Registration and Fishing Gear Licensing

Fishing vessel registration and fishing gear licensing are among the pre-requirements for the AMSs to be able to export fish and fishery products to the EU market. Most AMSs have indicated that the promotion of the EC IUU Regulation has created positive impacts on the respective countries' advocacy on fishing vessels registration and fishing gear licensing, as the numbers of fishing vessels registered and fishing gears licensed had tremendously increased, demonstrating

the objective of AMSs to target the lucrative fish market in the EU. However, some fishers and vessel operators also indicated that compliance with the EC IUU Regulation made them incur additional costs for the registration and licensing processes. Notwithstanding the consequences, the AMSs have cooperated with the Southeast Asian Fisheries Development Center (SEAFDEC) in the development of the Regional Fishing Vessels Record (RFVR) for vessels 24 meters in length and over (Kawamura and Siriraksophon, 2014). With funding support from the Japanese Trust Fund, the RFVR is envisioned as a tool to combat IUU fishing in Southeast Asian waters (Pongsri *et al*., 2014). Later, the RFVR would be extended to include information on vessels below 24 meters in length (SEAFDEC, 2015a) considering that this group of vessels which comprises more than 80% of the region's fishing vessels could also be involved, one way or another in IUU fishing (Matsumoto *et al*., 2012).

The RFVR database

In addition, the RFVR Database had been established through a series of ASEAN-SEAFDEC fora convened mainly to enhance the understanding of various stakeholders on the rationale of compiling and sharing information in the RFVR Database as this could provide the ways and means of managing fishing capacity and combating IUU fishing in the region. The RFVR Database could also provide inputs to the Global Record of Fishing Vessels, Refrigerated and Transport Vessels, and Supply Vessels being developed by FAO. This Global Record is meant to serve as catalyst in improving global transparency and traceability in the fisheries sector, and ultimately in combating IUU fishing worldwide.

Use of Log Books and Log Sheets

The promotion of the EC IUU Regulation in the Southeast Asian region has led to improved collection and compilation of fisheries data by the AMSs. More specifically, the efforts of AMSs in advocating the use of logbooks and log sheets had paved the way not only for improving fisheries data collection but also on the traceability of the fish and fishery products from the Southeast Asian countries. In the case of Singapore, however, the EC IUU Regulation has no impact in the country's fisheries data collection *per se*, as its fishers have been using logbooks and log sheets for a long time. Nevertheless, most AMSs had been confronted with negative impacts brought about by the promotion of the EC IUU Regulation that include difficulties in filling-up the log books and log sheets, generally considered as additional workload on the part of fishing masters or boat skippers. Most skippers had allegedly indicated that such additional tasks had caused delays in catching, and in landing and transporting the fish catch. As a result, increased administrative costs had been incurred by the governments as well as fishing managers, especially in terms of manpower, facilities and supplies.

Awareness/Cooperation of Fishers

The EC IUU Regulation has increased the awareness of fishers in most AMSs on the negative impacts of IUU fishing. By complying with the EC IUU Regulation, the skills and knowledge of fishers in the AMSs had been enhanced, especially in food safety as well as in reducing conflicts between commercial and traditional fishers that result in the high margin of marketability of the region's fish and fishery products worldwide. Although Singapore had indicated that the EC IUU Regulation has no impact on the country's fishers as their fish catch is not being exported to the EU, the other AMSs cited that one of the negative impacts of the implementation of the EC IUU Regulation is the additional

Box 1. Impacts on the health of the fishery resources from compliance with the EC IUU Regulation by AMSs	
Cambodia	The fishery resources had been enhanced as more fishers are undertaking fishing ground conservation and increasing their awareness on the effects of IUU fishing on the fishery resources and fishery habitats.
Indonesia	Fishing activities and the fishery resources have been managed in an orderly manner.
Lao PDR	Conservation areas in the country's inland waters have been created for the sustainability of inland fishery resources.
Malaysia	Efforts in enhancing the marine ecosystem and promoting resources conservation had been intensified, considering that by reducing or eliminating IUU fishing, the fishery resources for small-scale fisheries could be enhanced.
Myanmar	Efforts in preserving the marine ecosystem had been intensified by promoting resources conservation, considering that by reducing or eliminating IUU fishing, the fishery resources for small-scale fisheries could be enhanced.
Philippines	Degradation of habitats and resources had been abated and more productive marine resources have been developed when IUU fishing had been considerably reduced, while management of stocks of commercial migratory fishes has been improved contributing to the sustainability of the resources as well as that of fishing as a livelihood.
Thailand	Enhanced conservation measures for the marine ecosystem and resources had been developed, resulting in sustained abundance of the fishery resources.
Viet Nam	Efforts in preserving the marine ecosystem had been intensified by promoting resources conservation, considering that by reducing or eliminating IUU fishing, the fishery resources for small-scale fisheries could be enhanced.

Box 2. Impacts of the EC IUU Regulation on management of landings at fishing ports/landing sites by AMSs		
Country	**Positive Impacts**	**Negative Impacts**
Cambodia	Actions to promote overall knowledge on hygiene, safe products and good fish handling and transfer practices had been undertaken even beyond fish landing sites.	Additional budget is required to continue regular inspections at landing sites.
Indonesia	Management at certain fish landing sites or ports had been strengthened especially in some ports designated as local competent authority (LCA) to issue Catch Certificates, while data collection on fishing and trading had been improved.	Issuing catch certificates by LCA is an additional workload for fish port managers.
Lao PDR	Good fish handling and hygiene practices had been promoted and enhanced.	Additional costs needed to improve relevant infrastructures and enhance management of landings at fishing ports.
Malaysia	Good fish handling and hygiene practices had been promoted and enhanced.	Additional manpower and budget needed for enforcement, inspection, recording during landings as well as improving infrastructures.
Myanmar	Good fish handling and hygiene practices had been promoted and enhanced.	Additional manpower and budget needed for enforcement, inspection, recording during landings as well as for infrastructures improvement.
Philippines	Management of catch at landing sites had improved because of catch documentation requirements and easy access in monitoring the landings, while handling and food safety measures had been developed and the skills of stakeholders on food safety enhanced.	
Thailand	Management of landings at fishing ports had been promoted and enhanced while good fish handling and hygiene practices advocated, as well as collaboration between the government and private sector that supports the port state measures had been established.	Additional manpower and budget necessary for enforcement, inspection, recording during landings as well as improving infrastructures.
Viet Nam	Good fish handling and hygiene practices had been promoted and enhanced.	Additional manpower and budget needed for enforcement, inspection, recording during landings as well as improving relevant infrastructures.

budget needed for regular surveillance of their respective countries' fishing operations.

Fishery Resources

Through the EC IUU Regulation, most AMSs have recognized that combating IUU fishing had positive impacts on the health of the fishery resources (**Box 1**). However, some AMSs were also concerned with the additional costs incurred in complying with the said Regulation. In particular, Cambodia had experienced difficulties in promoting the EC IUU Regulation as compliance with the Regulation is costly and the country has insufficient funds for promoting the Regulation nationwide.

Management of Landings at Fishing Ports or Landing Sites

After the EC IUU Regulation had been put into force, most AMSs cited that fish handling practices at sea and at ports had been improved. However, the countries also expressed the concern that higher inspection costs could be incurred while checking the landings at fishing ports or in landing sites (**Box 2**).

Fish Raw Materials and Management of Processing Plants for Catch Certification

Many AMSs indicated that the EC IUU Regulation had created positive impacts on handling and processing of fish for exports. Nonetheless, many countries also feared that increased costs could be incurred in documentation works, enforcements, and other relevant activities.

Law Enforcement

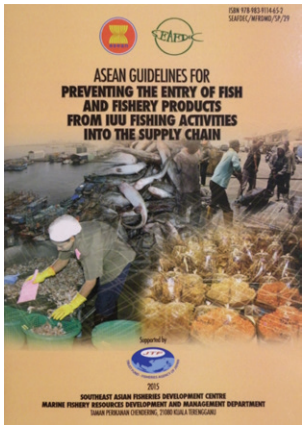
The AMSs have their respective fishery laws and regulations in place, and strict enforcement of such laws and regulations could eventually reduce IUU fishing (**Box 3**), although many countries also expressed the concern on additional manpower and budget that would be needed to strictly enforce such laws. The persistent occurrence of IUU fishing activities that extend

Box 3. Impacts of the EC IUU Regulation on enforcement of relevant laws and regulations in the AMSs

Country	Positive Impacts	Negative Impacts
Cambodia	Regular control and inspection activities had been carried out by Fisheries Administration with the cooperation of local authorities and other competent agencies.	High cost would be incurred in the inspection of all fishing activities in accordance with the national fisheries law.
Indonesia	Law enforcement especially for IUU fishing practices had been strengthened while amendment to the country's existing laws and regulations had been considered to make these attune with the EC IUU Regulation and relevant RFMOs resolutions (*e.g.* licensing regulations, observers onboard program, installation of VMS in fishing vessels).	
Lao PDR	Amendment of existing laws and regulations has been planned with Government policies to reduce IUU fishing in small-scale inland fisheries.	Difficulties in designating additional manpower to implement the policies as this would entail additional costs.
Malaysia	Amendment to existing laws and regulations had been undertaken to be in tune with the EC IUU Regulation (*e.g.* licensing regulations, quality control of fish for export to the EU), and to reduce IUU fishing in small-scale fisheries.	Difficulties in designating additional manpower to implement the laws and regulations as this would require additional costs.
Myanmar	Directives and notifications had been issued leading to effective monitoring, control and surveillance system, while cooperation among stakeholders and fishers had been enhanced.	Difficulties in designating additional manpower to implement the regulations due to additional costs required.
Philippines	Amendment of relevant policies had been effected incorporating catch documentation requirements and sanctions had been increased to obtain more deterrent effects. A holistic approach to law enforcement has been promoted by integrating flag state, port state and coastal state responsibilities. As a result, IUU fishing is significantly lessened due to the need for exporters to source fish only from licensed fishing vessels.	
Singapore	Work towards reducing IUU fishing in small-scale fisheries had been sustained.	Additional administrative procedures needed for enforcement officers.
Thailand	Existing laws and regulations had been amended with the objective of reducing IUU fishing in the country.	Difficulties in designating additional manpower as additional funds needed.
Viet Nam	Existing laws and regulations had been amended with the ultimate goal of decreasing IUU fishing in the country's small-scale fisheries.	Difficulties in designating additional manpower as additional funds needed.

to illegal trading of IUU fishes in the Southeast Asian region is mainly caused by weak enforcement of legislations and incompatible legal frameworks for combating IUU fishing (Kawamura and Siriraksophon, 2014).

For such reason, the AMSs cooperated with SEAFDEC for the development of the ASEAN Guidelines for Preventing the Entry of Fish and Fishery Products from IUU Fishing Activities into the Supply Chain (SEAFDEC/MFRDMD, 2014a; Kawamura and Siriraksophon, 2014). Funded by the Japanese Trust Fund, the development of such ASEAN Guidelines aimed to establish the foundation that could serve as basis in formulating relevant policies at national level as well as in developing clear direction and understanding of the need to prevent the entry of IUU fish and fishery products into the supply chain. Although the development of this ASEAN Guidelines took into consideration relevant international instruments, *e.g.* IPOA IUU Fishing, EC IUU Regulation, implementation would need additional budget for capacity building of concerned stakeholders in the respective AMSs.



Monitoring, Control and Surveillance (MCS)

Most countries had experienced the positive impacts from complying with the EC IUU Regulation not only in enhancing law enforcement but also in strengthening the cooperation among enforcement agencies (**Box 4**). However, the countries were also concerned on the increased costs incurred for putting up additional infrastructures and more manpower for the effective enforcement of the laws and regulations.

Recognizing that MCS is also a vital and crucial component of fisheries management and tool to combat IUU fishing in the region (Yleaña and Velasco, 2012), the AMSs had been actively participating in relevant fora convened by SEAFDEC with collaborating partners. In the process, the AMSs have been considering to establish a regional MCS network not only as means of strengthening MCS capabilities and satisfying the obligations arising from international agreements and instruments but also in their respective national responsibilities in performing MCS functions. Nonetheless, the varying legal mandates, systems of data collection, and research levels in the AMSs makes it difficult to monitor the status of the fishery resources at bilateral or sub-regional or regional level, although the AMSs also recognized that strengthening cooperation could enhance the means of exchanging fisheries data for MCS purposes.

Enhancing Governance

Governments have been playing the big role in supporting fishers and fishery workers in terms of better working conditions and living standards, as well as on policy concerns. However, some countries expressed the concern on insufficient budgetary allocations to be able to comply with the EC IUU Regulation (**Box 5**). The AMSs also recognized that intra-regional and international trade of fish and fishery products is beyond trading with the EU, thus, the countries agreed to develop measures that could provide them with guidance in

Box 4. Impacts of complying with the EC IUU Regulation on the promotion of MCS by AMSs

Country	Positive Impacts	Negative Impacts
Cambodia	Cooperation among competent agencies had been enhanced.	High cost for inspection of fishing activities.
Indonesia	The sole responsibility of undertaking MCS assigned to only one Office.	
Lao PDR	Law enforcement and cooperation among enforcement agencies had been improved.	Additional costs for more infrastructures and increased manpower for MCS.
Malaysia	Law enforcement and cooperation among enforcement agencies had been improved.	More infrastructures needed to enhance monitoring and control of fishing activities.
Myanmar	Law enforcement and cooperation among enforcement agencies had been improved.	More infrastructures needed to enhance monitoring and control of fishing activities.
Philippines	Installation of VMS for high-seas fishing generally accepted but not for domestic fishing, patrol vessels had been acquired while information and data gathering has been improved, and compliance with fishery regulations had increased.	MCS entails increased operational costs on the part of the government.
Singapore	Cooperation among enforcement agencies has been enhanced.	More infrastructures, assets, manpower and costs needed.
Thailand	Law enforcement and cooperation among the government and private sectors has been improved.	More infrastructures, assets, manpower and costs needed.
Viet Nam	Law enforcement and cooperation among the government and private sectors has been improved.	More infrastructures, assets, manpower and costs needed.

Box 5. Impacts of the EC IUU Regulation on improved fisheries management by governments in AMSs		
Country	**Positive Impacts**	**Negative Impacts**
Cambodia	Working conditions, lives of fishers and facilities improved, while timely availability of fish increased. Stakeholders' support to fishery policies based on national Fishery Law and regulations had been enhanced.	More infrastructures and funds needed to sustain support in fishery activities.
Indonesia	Commitment to implement the Catch Certification and EC IUU Regulation assured through the issuance on Ministerial Regulation Number: PER.13/MEN/2012 on Indonesia Catch Certification.	
Lao PDR	Working conditions in capture, processing and other co-management aspects had improved.	More infrastructures, manpower and funds needed to implement the EC IUU Regulation.
Malaysia	Working conditions in capture fisheries as well as in processing and other areas in the supply chain had improved. Policy support from government agencies enhanced, from food safety to trading systems. Better living standards could be seen as spill-over effect.	More infrastructures, manpower and funds needed to comply with the EC IUU Regulation.
Myanmar	Working conditions in capture fisheries and living standards of fishers as well as in processing and other areas in the supply chain had improved. Policy support from government agencies enhanced, from food safety to trading systems.	More infrastructures, assets, manpower and costs are needed to be able to adopt the EC IUU Regulation.
Philippines	Relevant national policies had been revised while plans were made to ratify fisheries-related international agreements such as the 2009 Port State Measures and Compliance Agreement. Budgetary allocations for fisheries management had been increased resulting in strengthened capabilities of municipal governments in fisheries management. Cooperation with other States to combat IUU fishing at bilateral or regional levels strengthened, information dissemination to fishery stakeholders through workshops and consultations on the impacts of IUU fishing intensified, while improved production from capture fisheries increased the supply of raw materials for the processing sector.	
Singapore		More infrastructures, manpower and funds are needed.
Thailand	Working conditions in capture fisheries and living standards of fishers as well as in processing and other areas in the supply chain had improved. Policy support from government agencies enhanced, especially on fisheries management and sustainable development of the resources.	More infrastructures, manpower and costs are needed to be able to comply with the EC IUU Regulation.
Viet Nam	Working conditions in capture fisheries and living standards of fishers as well as in processing and other areas in the supply chain had improved. Policy support from government agencies enhanced, from food safety to trading systems.	More infrastructures manpower and costs needed to enable the country to comply with the EC IUU Regulation nationwide.

improving the traceability system of capture fisheries and eventually, in combating IUU fishing in the region (Kawamura and Siriraksophon, 2014). With assistance from SEAFDEC and funding support provided through the Japanese Trust Fund, the countries initiated the development of the ASEAN Catch Documentation Scheme (ACDS) as a management tool for combating IUU fishing and enhancing inter-regional and international trade of fish and fishery products from the region.

Economic Aspects

During the past five years (2009-2013), production from capture fisheries of the AMSs had considerably increased not only in terms of quantity but also in terms of value, as shown in **Table 1** (SEAFDEC, 2015). As a consequence, most of these countries had also improved their export opportunities resulting in enhanced economies. However, the countries expressed the concern on low supply of raw materials for export from complying fishing vessels (**Box 6**), notwithstanding the number of powered fishing boats in the region which could be more than 500,000 (SEAFDEC, 2014). Nevertheless, through the efforts of SEAFDEC and with funding support from the Japanese Trust Fund, the AMSs had been enhancing the capacity of their respective fishers in improving post-harvest handling of fish onboard fishing vessels to ensure that discards onboard are brought

Table 1. Fishery production of Southeast Asia (2009-2013): quantity (QTY) in million metric tons; value (VAL) in billion US Dollars

	2009		2010		2011		2012		2013	
	QTY	VAL	QTY	VAL	QTY	VAL	QTY	VAL	QTY	VAL
Marine Capture	14.2	10.5	14.9	15.9	15.1	21.2	15.6	20.1	16.3	20.4
Inland Capture	2.4	2.6	2.4	2.5	2.7	2.9	2.8	3.2	2.9	3.3
Aquaculture	12.3	16.1	14.2	13.4	15.8	19.7	21.2	21.7	20.9	18.2
TOTAL	**28.9**	**29.2**	**31.5**	**31.8**	**33.6**	**43.8**	**39.6**	**45.0**	**40.1**	**41.9**

Source: SEAFDEC (2015)

Box 6. Impacts of complying with the EC IUU Regulation on the economic aspects of fisheries in AMSs

Country	Positive Impacts	Negative Impacts
Cambodia	Improved infrastructure led to enhanced fishery opportunities, safety and good hygiene of fish and fishery products.	Minimal activities carried out, especially on fishery enhancement and in promoting all fishery operations.
Indonesia	Volume of seafood export to the EU market could be increased.	In Catch Certificate verification process, fish containers are kept on hold and released only after getting clarifications, making the situation and process costly and creating burden to exporters.
Lao PDR	Export opportunities of fish and fishery products improved creating income generating options for households.	
Malaysia	Export opportunities of fish and fishery products improved.	Low supply of raw materials for export from complying fishing vessels, *e.g.* anchovy, prawns/shrimps, squid while tariff barrier still exists due to absence of free trade agreement (FTA).
Myanmar	Export opportunities of fish and fishery products improved.	Low supply of raw materials for export from complying fishing vessels (anchovy, prawns/shrimps, squid).
Philippines	Product quality and safety simultaneous with traceability had improved thus, continued market access of fish and fishery products to EU member countries is ensured.	Loss of market access for those who cannot comply with EC IUU Regulation, so that fishing operators spend additional amount of money to comply with the EC IUU Regulation.
Singapore	Improved export opportunities of fish and fishery products.	
Thailand	Improved export opportunities of fish and fishery products, while quality of products is guaranteed due to high competition.	Low supply of raw materials for export from the complying fishing vessels.
Viet Nam	Improved export opportunities of fish and fishery products.	Low supply of raw materials for export from the complying fishing vessels, *e.g.* anchovy, prawns/shrimps, squid, octopus. Tariff barrier still exists due to absence of FTA.

to the barest minimum, therefore, optimizing the quantity and quality of catch.

Conclusion and Recommendations

Many Southeast Asian countries are exerting efforts to increase the export competitiveness of their fish and fishery products to the EU market by complying with the EC IUU Regulation and other international instruments. However, there are still provisions in the EC IUU Regulation that could not be easily promoted such as allocating additional budget to develop and enhance infrastructures, especially those that are needed in monitoring national fishing activities. In addition, funds are needed to undertake capacity building for effective and efficient enforcement of laws and regulations, and for improved collection of data and information on fisheries.

Nevertheless, such concerns should be addressed by the governments to improve the competitiveness of their fish and fishery products not only for export to EU but also for domestic consumption and trade. Moreover, for the well-being of workers in fisheries, it is also necessary that governments should work for improving the lives and working conditions of fishers and fish workers, ensuring them of adequate protection in accordance with the respective countries' labor laws.

In a recent development, the EU has lifted the "yellow card" sanctioned to the Philippine Government almost a year ago (Philippine Star, 22 April 2015). The "yellow card" is an official warning for governments' failure to combat IUU fishing in their respective waters. With the "yellow card" the concerned countries would be given six months to improve their mechanisms to combat IUU fishing as this often led

to over-exploitation of fishing grounds and depletion of the marine resources. In the case of the Philippines, its Fisheries Code of 1998 had been amended and strengthened, and strictly implemented. As a result of the strict enforcement of laws and regulations, the "yellow card" issued to the Philippines by the EU had been lifted meaning that the Philippines could export fish and fishery products to the EU market.

In a similar development, the EU has issued an official warning that could slap a ban on Thailand if the country fails to take actions in combating IUU fishing within six months (The Nation, 23 April 2015). If Thailand could not undertake the necessary measures, this ban could have huge impact on the country's fishery industry since its fishery products could no longer be exported to the EU which is one of the major markets of the country's products, especially canned tuna. Thailand is now taking emergency steps to address this concern, such as amendments of its Fishery Law and regulations including addressing the issues related to labor, *i.e.* labor protection of fishers and fish workers in the country's fishing industry.

Furthermore, it is also necessary that bilateral, sub-regional and regional arrangements, whether formal or informal, should be strengthened in order that data and information are effectively exchanged, more particularly those on IUU fishing in Southeast Asian waters. Strengthening regional and sub-regional efforts to combat IUU fishing in the region is a priority action for the ASEAN Economic Community unification (Poernomo *et al*., 2011). Through such arrangements, lessons could be learned and experiences could be shared among the AMSs with regards to the development of mechanisms and measures to combat IUU fishing, as this could prevent the issuance of sanctions from the EU and result in sustained trading of fish and fishery products in the world market. The AMSs should also continue and sustain the development of their respective National Plans of Action to Prevent, Deter and Eliminate IUU Fishing (NPOAs-IUU) in accordance with the International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (IPOA-IUU).

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CALENDAR OF EVENTS

Date	Venue	Title	Organizer(s)
2016			
11-31 May	TMS-Philippines	Training Course on Abalone Hatchery and Grow-out	SEAFDEC/AQD
11 May-1 Jun	TMS-Philippines	Training Course on Mud Crab Hatchery and Nursery Operations	SEAFDEC/AQD
16-17 May	Thailand	Expert Meeting on Assessment of the Proposed Listing Commercially Exploited Aquatic Species to the CITES Appendix	SEAFDEC/Secretariat
16-19 May	Kuala Lumpur, Malaysia	Regional Technical Consultation on Enhancing Coastal Community Resilience for Sustainable Livelihood and Coastal Resources Management	SEAFDEC/MFRDMD
16-20 May	BFS-Philippines	Training Course on Freshwater Prawn Hatchery & Grow-out Operations	SEAFDEC/AQD
19-20 May	Thailand	Regional Consultation for Development of the Common Position on the Proposed Listing Commercially Exploited Aquatic Species to the CITES Appendix	SEAFDEC/Secretariat
23-25 May	Bangkok, Thailand	14th INFOFISH World Tuna Trade Conference and Exhibition	INFOFISH
23-27 May	Thailand	Training of Trainers on Essential Ecosystem Approach to Fisheries Management for Thailand	SEAFDEC-Sweden Project
30-31 May	Philippines	8th Meeting of the ASEAN Fisheries Consultative Forum (AFCF)	ASEAN
1-3 June	Philippines	24th Meeting of the ASEAN Sectoral Working Group on Fisheries (ASWGFi)	ASEAN
7-9 June	Bangkok, Thailand	Regional Technical Consultation on Development of Regional Guidelines for Small-Scale Fisheries in the Southeast Asian Region	SEAFDEC/Secretariat
13-22 June	TMS-Philippines	Training Course on Mud Crab Nursery & Grow-out Operations	SEAFDEC/AQD
13 Jun-19 Jul	TMS-Philippines	Training Course on Marine Fish Hatchery	SEAFDEC/AQD
20-25 June	Cambodia	E-EAFM Training for Cambodia	SEAFDEC-Sweden Project
28-30 June	Cambodia (tentative)	3rd Meeting of the Scientific Working Group on Stock Assessment of Neritic Tunas	SEAFDEC/Secretariat
4-14 July	Samut Prakan, Thailand	Regional Training Workshop on Larval Fish Identification and Fish Early-life History Science (Advanced course: Key to Species)	SEAFDEC-Sweden Project
9-15 July	Rome, Italy	6th meeting of the Regional Fishery Body Secretariats Network (RSN)	FAO
11-15 July	Rome, Italy	32nd Session of FAO Committee on Fisheries	FAO
18-22 July	Singapore	Regional Training Course on Identification of Biotoxin-producing HAB Species in the ASEAN Region	MFRD
July-December (tentative)	TMS-Philippines	Distance Learning Course on Principles of Aquaculture Nutrition (ANOL)	SEAFDEC/AQD
3 August	Bangkok, Thailand	High-level Consultation on Regional Cooperation in Sustainable Fisheries Development Towards the ASEAN Economic Community	SEAFDEC/Secretariat
4-6 August	Bangkok, Thailand	ASEAN Fisheries Conference and ASEAN Seafood Exposition	Thai DOF, NACA, SEAFDEC
8-10 August	Palembang, Indonesia	1st Workshop to Review Activities and Methodologies for Promotion on Inland Fishery	SEAFDEC/IFRDMD
23-25 August	Kuala Lumpur, Malaysia	Regional Technical Consultation Meeting for Purse Seine Fishery in the Southeast Asian Region	SEAFDEC/MFRDMD
12-16 September	BFS-Philippines	Training Course on Freshwater Prawn Hatchery & Grow-out Operations	SEAFDEC/AQD
12-23 September	TMS-Philippines	Training Course on Seaweed Farming	SEAFDEC/AQD
12 Sep 2016 -26 Feb 2017	TMS-Philippines	Distance Learning Course on Principles of Health Management in Aquaculture (AHOL)	SEAFDEC/AQD
24 Sep-5 Oct	South Africa	17th Conference of the Parties of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	CITES
10-14 October	TMS-Philippines	Training Course on Catfish Hatchery and Grow-out Operations	SEAFDEC/AQD
28-30 November	Indonesia	39th SEAFDEC Program Committee Meeting (PCM)	SEAFDEC
1-2 December	Indonesia	19th Meeting of the Fisheries Consultative Group of the ASEAN-SEAFDEC Strategic Partnership (FCG/ASSP)	ASEAN-SEAFDEC

Southeast Asian Fisheries Development Center (SEAFDEC)

What is SEAFDEC?

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

Mandate

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

Objectives

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

SEAFDEC Program Thrusts

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


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The second prize drawing winner, *Putri Hastifah I.*, from the national drawing contest in Indonesia

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.