FISH for the PEOPLE

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

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Advancing management approaches and novel technologies for sustainable development of Southeast Asian fisheries and aquaculture

Southeast Asian Fisheries Development Center

Editor in Chief (Fish for the People)

SEAFDEC Secretariat
Kasetsart University Campus
P.O. Box 1046, Kasetsart Post Office
Bangkok 10903, THAILAND
E-mail: fish@seafdec.org

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Editorial

Fisheries have been playing important roles in the socioeconomic structure of many countries in the world, especially in Southeast Asia. In addition to supplying the source of protein for many, fisheries have always played a fundamental part in enhancing the world economies and providing job opportunities to a lot of people, making it critical for the sustainable management of the fisheries for the future generations.

In the Southeast Asian region, the need to enhance the integration of habitat and biodiversity conservation into fishery management and practices has been realized through the establishment of fisheries *refugia*, which is considered an important approach for the conservation and management of major critical coastal habitats including mangroves, coral reefs, and seagrass beds. The countries in the region recognized that a comprehensive structural framework, criteria, and indicators are essential components of effective fisheries *refugia* to manage the intense levels of small-scale fishing pressures that exert unsustainable pressure on the fisheries and the environment. Specifically, indicators that reflect broad ecological, social, economic, and institutional objectives could provide supplementary information to improve sustainable fisheries management and formulate fishery management policies and frameworks.

For aquaculture, technologies are continued to be developed to enhance the reproduction of economically important cultured penaeid species as well as recuperate threatened fish species. However, slow growth, diseases, and low reproduction are among the challenges in closing the life cycle in captivity and domesticating shrimp; thus, novel strategies are being explored to manipulate sex-specific nutritional requirements and enhance the maturation and mating of male and female broodstock. Meanwhile, experimental farming of threatened freshwater fish revealed unfeasible results due to slow growth, predatory behavior, and high feed requirement; nevertheless, research on broodstock rearing, spawning, and hatching is underway to support conservation efforts.

Due to COVID-19, the government-imposed lockdowns made negative and positive impacts on the fisheries sector of major fishing countries of the region. Although the closure harmed the ecotourism industry, the local people have found sustainable ways to survive through the crisis such as returning to fishing and farming while not abandoning their environmental conservation initiatives. Measures have also restricted trade which led to a decline in demand for fish and fishery products. On the other hand, lockdowns did not stop illegal fishing, particularly encroachment of commercial fishing in areas that are restricted to small-scale fishing. Nonetheless, the countries remained vigilant to apprehend illegal fishing practices by sustaining the enforcement activities despite COVID-19 restrictions.

Recently, the use of information technologies had been strengthened to include not only monitoring and tracking the activities of fishing vessels but also monitoring, managing, and warning of any environmental problems in coastal areas. The technologies are also being used for mobile catch documentation applications for small-scale fish suppliers and buyers, and also serve as communication devices, enabling small-scale fishers to participate in electronic catch documentation traceability and establish increased communication and safety at sea. These technologies are therefore potential tools for utilization in data and information compilation and various analyses, the results of which could be used in decision making and in formulating management strategies for sustainable utilization of fishery resources.

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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 Southeast Asian region.

Integrating Habitat Conservation and Fishery Management in the South China Sea and Gulf of Thailand through Fisheries *Refugia*

Somboon Siriraksophon

The integration of habitat and biodiversity conservation into fishery management and practices in the South China Sea and the Gulf of Thailand has been improved through the efforts of concerned communities and governments. This approach was made possible under the project "Establishment and Operation of a Regional System of Fisheries *Refugia* in the South China Sea and the Gulf of Thailand" supported by the Global Environment Facility (GEF) and United Nations Environment Programme (UNEP). The Project was implemented by the Southeast Asian Fisheries Development Center (SEAFDEC) in partnership with the fisheries agencies of the riparian countries bordering the South China Sea, namely: Cambodia, Indonesia, Malaysia, Philippines, Thailand, and Viet Nam. The main focus of the Project was establishing a regional system of fisheries *refugia*, which are fisheries management areas, in the South China Sea and Gulf of Thailand. Initially planned for 48 months from January 2017 until December 2020, the Project duration was extended until December 2022 due to the COVID-19 pandemic. Nevertheless, as of June 2022, the communities in the fisheries *refugia* sites of the participating countries have been working towards enhancing the integration of habitat and biodiversity conservation into fishery management and practices for the economically important aquatic species.

By 2022, the effective management of critical threats to 15 fisheries *refugia* sites with a total area of about 1.36 million ha is expected to be adopted. This is more than five times of the proposed *refugia* areas (269,500 ha) adopted by the GEF/CEO. Among these, five fisheries *refugia* were agreed upon among stakeholders and approved by the governments, including three in Cambodia at Kep Province for blue swimming crab, Preah Sihanouk for blood cockle, and Koh Kong Province for Indo-Pacific mackerel; and two in Thailand at Surat Thani Province for blue swimming crab and Trat Province for Indo-Pacific mackerel. In addition, seven fisheries *refugia* sites were recognized by the stakeholders and will be adopted by the responsible agencies. These include one in Cambodia at Kampot Province for the juvenile grouper; two in Malaysia at Tanjung Leman, Johor State for spiny lobster and at Miri, Sarawak State for tiger prawn; three in the Philippines at Bolinao for siganids, at Masinloc for one-stripe fusilier, and Coron for redbelly yellowtail fusilier; and two in Indonesia at West Kalimantan for white prawn, and at Bangka Regency for squid. Moreover, although the activities in Viet Nam were delayed, the country have identified two *refugia* sites, one at the Eastern coastal area of Phu Quoc – Kien Giang for blue swimming crab, and another at the coastal area of Lagi, Binh Thuan for subcrenata ark clam.

As a regional system of management areas that focuses on essential links between fish stocks and their habitats, fisheries *refugia* have been considered an important approach for the conservation and management of major critical coastal habitats, *e.g.* mangroves, coral reefs, seagrass beds. In the Regional Guidelines on the Use of Fisheries *Refugia* for Capture Fisheries Management in Southeast Asia adopted in 2006, promoting the concept of fisheries *refugia* is essential to enhance the existing conservation and management measures, especially in the integration of fisheries with habitats management (SEAFDEC, 2006).

Many Southeast Asian countries have established their respective fisheries *refugia*, but there is a need to enhance the operations of such *refugia* systems in order for these to also support the concept of other effective area-based conservation measures or OECM that has been promoted by the Convention on Biological Diversity (CBD) framework and included in the target of the post-2020 global biodiversity framework (CBD, 2021). The fisheries *refugia* approach is meant to manage intense levels of small-scale fishing pressures that exert unsustainable pressure on the fisheries and the environment, especially in the South China Sea and Gulf of Thailand areas, which is a global center of marine biological diversity that supports significant fisheries that are important to the food security and economic stability of Southeast Asian countries. Among the most productive fishing grounds in the South China Sea area include the Gulf of Thailand which features a large amount of small-scale and coastal fishing operations and is shared by Cambodia, Malaysia, Thailand, and Viet Nam; and the Eastern and Southern South China Sea that host large amount of small-scale and coastal fishing, small-scale vessels, and bordered by Indonesia, Malaysia, Philippines, and Viet Nam (Ekmaharaj *et al*., 2009)

Nevertheless, high levels of fishing effort from the small-scale sector have been recorded in the South China Sea area while inshore waters were also subjected to intense fishing pressure that led to the adoption of unsustainable fishing methods and practices to maintain catch and increase incomes in short term. Such practices include the use of destructive fishing gear and explosives; operation of demersal trawls and push nets in seagrass beds, and use of chemicals that poison not only the target fishes but also the corals in reef areas. The vigorous fishing pressure exerted by small-scale fisheries has therefore been identified as a significant cause of the degradation and loss of coastal habitats in the South China Sea.

Box. Definition of fisheries *refugia*

Fisheries *refugia* refers to "Spatially and geographically defined, marine or coastal areas in which specific management measures are applied to sustain important species [fisheries resources] during critical stages of their life cycle, for their sustainable use."

Thus, fisheries *refugia* should:

- not be simply 'no take zones';
- have the objective of sustainable use for the benefit of present and future generations;
- provide for some areas within *refugia* to be closed due to their critical importance [essential contribution] to the life cycle of a species or group of species;
- focus on areas of critical importance in the life cycle of fished species, including spawning and nursery grounds, or areas of habitat required for the maintenance of brood stock;
- have different characteristics according to their purposes and the species or species groups for which they are established and within which different management measures will apply; and
- have management plans.

Management measures that may be applied within fisheries *refugia* may be drawn from the following [non-exhaustive] list of classical fisheries management actions:

- exclusion of a fishing method (*e.g.* light luring, purse seine fishing);
- restricted gears (*e.g.* mesh size);
- prohibited gears (*e.g.* push nets, demersal trawls);
- vessel size/engine capacity;
- seasonal closures during critical periods of fish life cycles;
- seasonal restrictions (*e.g.* use of specific gear that may trap larvae); and
- limited access and use of rights-based approaches in small-scale fisheries.

The riparian countries of the South China Sea have been exerting efforts to reduce the rate of loss of coastal habitats, *e.g.* adoption of conventional fisheries management measures such as regulating the mesh size of nets and imposition of closed areas and closed seasons. Nonetheless, the rate of loss of such habitats remained high due to difficulties in the enforcement of such measures resulting in the impossibility of increasing or maintaining production levels (Siriraksophon, 2010). The continued decline of habitats critical to the life cycles of most aquatic species has raised serious concerns for the long-term sustainability of small-scale fisheries in the South China Sea. With fish production intrinsically linked to the quality and area of habitats and the heightened dependence of coastal communities on fish, the need to improve the integration of fish habitat considerations and fisheries management has become essential. Such a situation, therefore, called for the establishment of the fisheries *refugia*, where fisheries *refugia* as defined by the UNEP/GEF/SCS are the "spatially and geographically defined, marine or coastal areas in which specific management measures are applied to sustain important species (fisheries resources) during the critical stages of their life cycle, for their sustainable use" (Pernetta *et al.*, 2010).

As an initial attempt to address the concerns related to the widespread overexploitation of fish stocks in the Gulf of Thailand and South China Sea, the UNEP/GEF Project "Reversing Environmental Degradation Trends in the South China Sea and Gulf of Thailand" through its Regional Working Group on Fisheries (RWG-F) developed the initial concept

Supplementary Guidelines on Co-management Using Group User Rights, Fishery Statistics, Indicators and Fisheries *Refugia*

of fisheries *refugia* (Pernetta *et al*., 2010). Moreover, from 2002 to 2008, the Project collaborated with SEAFDEC and its Member Countries to refine this concept and develop a framework for the establishment and operation of a regional system of fisheries *refugia*, targeting priority transboundary, demersal fish, and non-finfish resources (UNEP, 2007). Considering that specific habitats and areas are critically important to different stages of the life cycle of each species, these areas have to be managed by adopting the fisheries *refugia* concept. During the implementation of the Project, efforts were made to address the key barriers to effective fisheries habitat management in the South China Sea and Gulf of Thailand. These barriers include limited information regarding fish life cycle and critical habitat linkages and the role that the marine habitats play in sustaining fisheries; low-level of understanding among stakeholders including fishers, scientists, policymakers, and fisheries and habitat managers of the linkages between fish stocks and habitats; limited community acceptance of "protected" area-based approaches to marine management in Southeast Asia; and limited experience of national fisheries and environment agencies with respect to the implementation of integrated fisheries and habitat management approaches (Siriraksophon, 2010). Despite such limitations, 52 known fisheries *refugia* had been identified and characterized, and the experiences and lessons learned had been used to develop the Regional Guidelines on the Use of Fisheries *Refugia* for Capture Fisheries Management in Southeast Asia that formed part of the ASEAN-SEAFDEC Regional Guidelines for Responsible Fisheries in Southeast Asia published by SEAFDEC in 2006 (Pernetta *et al*., 2010).

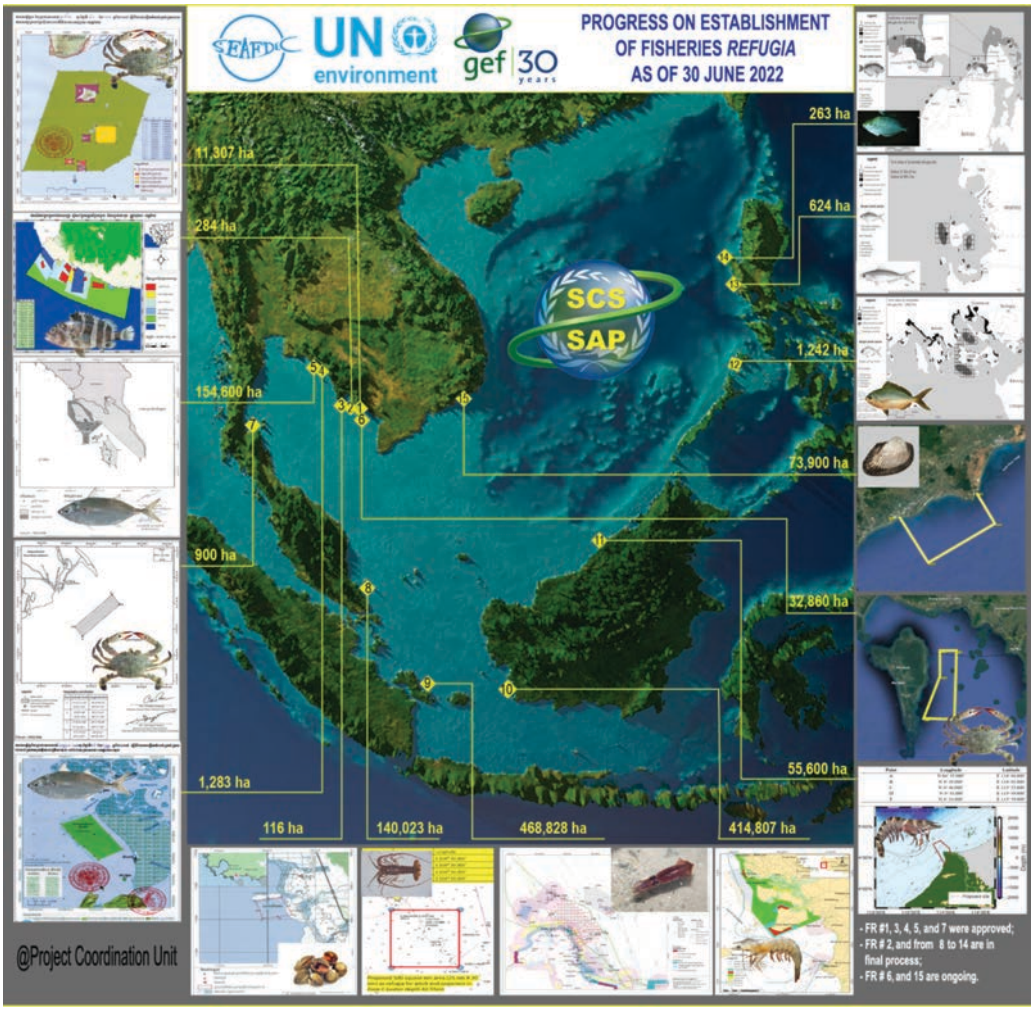
With the results of the 2002–2008 UNEP/GEF Project at the backdrop, and in order to improve the integration of fish habitat considerations and fisheries management in the South China Sea, the 2017–2022 Project "Establishment and Operation of a Regional System of Fisheries *Refugia* in the South China Sea and Gulf of Thailand" was implemented to meet this need via implementation of the fisheries component of the Strategic Action Programme for the South China Sea. The Project had the objectives of contributing to improved integration of habitat and biodiversity conservation considerations in the management of fisheries in the South China Sea and Gulf of Thailand; improving national management of the threats to fish stock and critical habitat linkages within fisheries *refugia*; and enhancing the uptake of good practice in integrating fisheries management and biodiversity conservation in the design and implementation of regional and national fisheries management systems. The four components of the Project were 1) establishing operational management at 15 priority fisheries *refugia* with community-based *refugia* management plans as key outputs; 2) strengthening the enabling environment for the formal designation and operational management of fisheries *refugia*; (3) strengthening information management and dissemination for enhancing the national uptake of best practices in integrating fisheries management and biodiversity conservation, and in improving community acceptance of area-based approaches to fisheries and coastal environmental management; and at the national level, (4) strengthening the cross-sectorial coordination for integrated fisheries and environmental management while harnessing national scientific and technical expertise, and knowledge required to promote policy, legal, and institutional reforms for fisheries *refugia* management in the participating countries.

Specifically, the Project was also aimed at aligning with the fisheries component of the Strategic Action Programme for the South China Sea, *viz*: build the resilience of Southeast Asian fisheries to the effects of high and increasing levels of fishing effort; improve the understanding among stakeholders, including fishers, scientists, policymakers, and fisheries managers, of the ecosystem and fishery linkages as a basis for integrated fisheries and ecosystem/habitat management; and build the capacity of fisheries agencies to engage in meaningful dialogue with the environment sector regarding the improvement of fisheries and management of interactions between fisheries and critical marine habitats. As of June 2022, the participating countries have made progress in their respective fishery *refugia*, where fisheries *refugia* management is being effectively implemented and promoted for certain economically important commodities prioritized by the countries. All 15 fisheries *refugia* sites with a total area of about 1.36 million ha are expected to be adopted by 2022. This is more than five times of the proposed *refugia* areas (269,500 ha) adopted by the GEF/CEO. As of June 2022, five *refugia* sites were approved, while the others were in the ongoing and final approval process.

Way Forward

Although the fisheries *refugia* establishment in Viet Nam has been delayed, fisheries management systems in the identified priority fisheries *refugia* were developed in the participating countries consistent with the ASEAN-SEAFDEC Regional Guidelines for Responsible Fisheries in Southeast Asia. Moreover, the draft Regional Guidelines on Indicators for

No. in map	Fisheries *refugia* site	Target species	Area (ha)	Status
1	Marine Fisheries Management including Refugia at Koh Po & Koh Tonsay Archipelago, Kep, Cambodia	Blue swimming crab (*Portunus pelagicus*)	11,307	Approved
2	Prek Thnaot, Kampot, Cambodia	Groupers	284	Final process
3	Prek Sangke, Village, Tek Thlar Commune, Prey Nub District, Preah Sihanouk, Cambodia	Blood cockle (*Anadara granosa*)	116	Approved
4	Peam Krasob, Koh Kong, Cambodia	Indo-Pacific mackerel (*Rastrelliger brachysoma*)	1,283	Approved
5	Off Trat, Thailand	Indo-Pacific mackerel (*Rastrelliger brachysoma*)	154,600	Approved
6	Eastern coastal area of Phu Quoc – Kien Giang, Viet Nam	Blue swimming crab (*Portunus pelagicus*)	32,860	Ongoing
7	Around Koh Sed, Surat Thani, Thailand	Blue swimming crab (*Portunus pelagicus*)	900	Approved
8	Tanjung Leman, Johor, Malaysia	Spiny lobster (*Panulirus polyphagus*)	140,023	Final process
9	Off Tuing Village, Bangka Regency, Indonesia	Squid (*Uroteuthis chinensis*)	468,828	Final process
10	Kubu Raya (Padang Tikar), Ketapang (Delta Pawan and North Kayong (Dusun Besar)/West Kalimantan, Indonesia	Penaeid shrimp (*Penaeus merguiensis*)	414,807	Final process
11	Kuala Balam, Miri, Sarawak, Malaysia	Black tiger prawn (*Penaeus monodon*)	55,600	Final process
12	Off Coron Islands, Palawan, Philippines	Redbelly yellowtail fusilier	1,242	Final process
		White-tipped scad (Option)	-	Ongoing
13	Masinloc coastal area, Zambales, Philippines	One-stripe fusilier	624	Final process
		Frigate tuna (Option)	-	Ongoing
		Fringe scale sardine (Option)	-	Ongoing
14	Bolinao coastal area, Pangasinan, Philippines	Siganids	263	Final process
15	Coastal area of Lagi – Binh Thuan, Viet Nam	Subcrenata ark clam (*Anadara subcrenata*)	73,900	Ongoing
		TOTAL AREA (ha)	**1,356,637**	



Fisheries *refugia* establishment (as of June 2022)

Sustainable Management of Fisheries *Refugia* is being prepared. The structural framework together with criteria and indicators to enhance the effective management of fisheries *refugia* have been defined by the participating countries. It is expected that the experience gained from this Project in the South China Sea area could be adopted in other marine areas of the world where overfishing and the use of inappropriate fishing gears and practices are significant impediments to the sustainable exploitation of fishery resources and utilization of coastal habitats.

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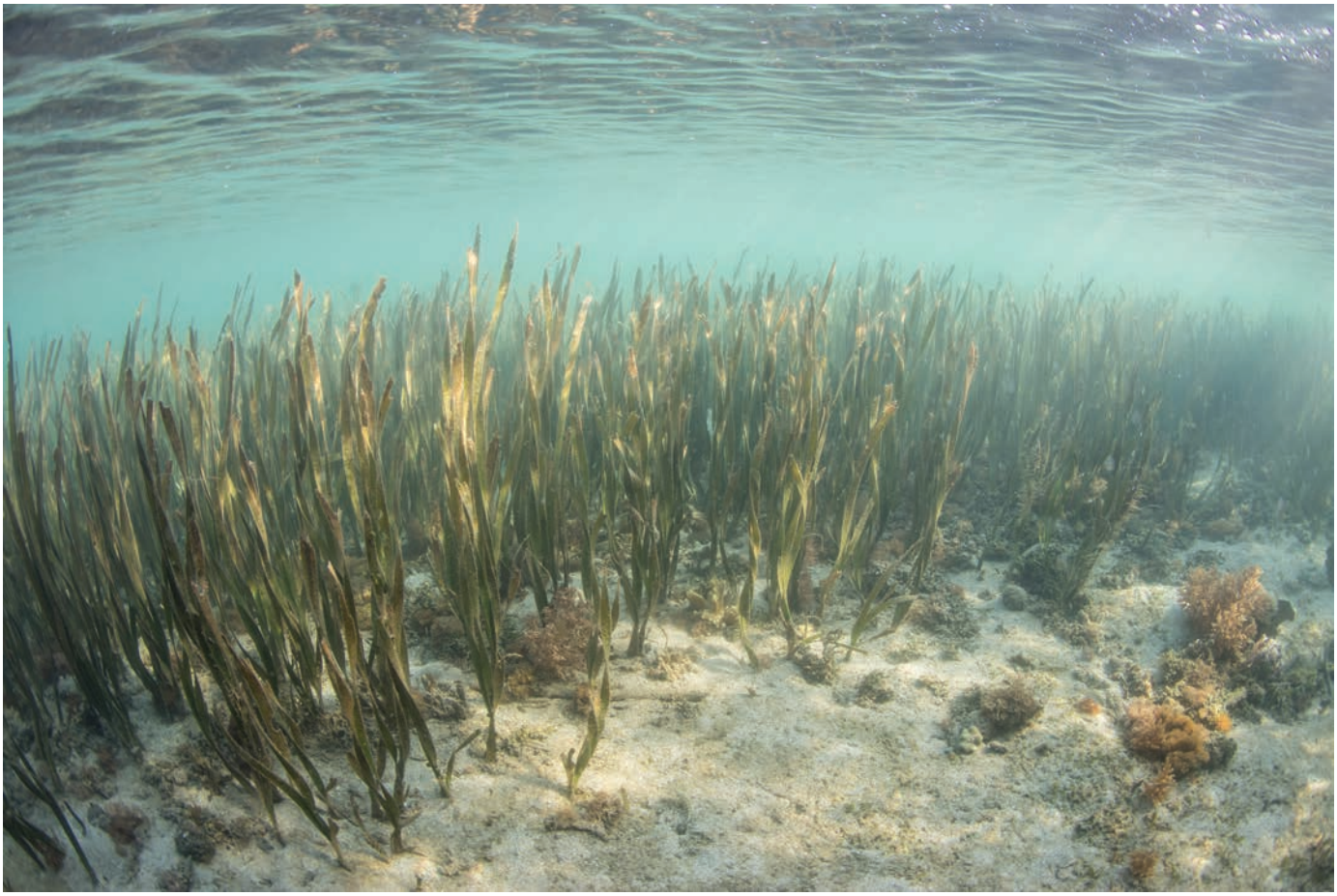
About the Author

Dr. Somboon Siriraksophon is the Project Manager of the SEAFDEC/UNEP/GEF Project "Establishment and Operation of a Regional System of Fisheries *Refugia* in the South China Sea and Gulf of Thailand." Email: ssiriraksophon63@gmail.com.



Establishing Indicators for Sustainable Management of Fisheries *Refugia*

Somboon Siriraksophon

The project "Establishment and Operation of a Regional System of Fisheries *Refugia* in the South China Sea and Gulf of Thailand" was developed as part of the implementation of the fisheries component of the Strategic Action Programme for the South China Sea. Supported financially by the Global Environment Facility (GEF) and implemented by the United Nations Environment Programme (UNEP) from 2016 to 2022, the Project was executed in the South China Sea area by the Southeast Asian Fisheries Development Center (SEAFDEC) in partnership with the fisheries agencies of the riparian countries of South China Sea, namely: Cambodia, Indonesia, Malaysia, Philippines, Thailand, and Viet Nam. The Project was mainly focused on establishing a regional system of fisheries management areas known as fisheries *refugia* in the South China Sea and Gulf of Thailand. The four components of the Project include 1) establishment of operational management at 14 priority fisheries *refugia*, with community-based *refugia* management plans being the key outputs; 2) strengthening of the enabling environment for the formal designation and operational management of *refugia*; 3) strengthening of information management and dissemination for enhancing the national uptake of best practices in integrating fisheries management and biodiversity conservation, and in improving community acceptance of area-based approaches to fisheries and coastal environmental management; and 4) strengthening the cross-sectorial coordination for integrated fisheries and environmental management while harnessing national scientific and technical expertise, and knowledge required to promote policy, legal and institutional reforms for fisheries *refugia* management in the participating countries. More specifically, the third component focused on information management which includes supporting activities that involve the development of national knowledge management systems on the use of fisheries *refugia* in capture fisheries management, establishment of a Regional Education and Awareness Centre as a facility for the production and sharing of information and education materials on fisheries and critical habitat linkages in the South China Sea area, development of indicators to monitor the effectiveness of coastal fisheries management systems established for priority fisheries *refugia*, and establishment of a regional program for the compilation of standardized fisheries statistics for identifying and managing fisheries refugia. During the implementation of the Project, the participating countries defined the structural frameworks together with criteria and indicators to enhance the effective management of fisheries *refugia* leading to the development of the Regional Guidelines on Indicators for Sustainable Management of Fisheries *Refugia*.

Indicators are crucial for monitoring the complex systems that need to be controlled, forming a critical part of everyone's life. Indicators are also part of the stream of information used to understand things, make decisions, and plan future actions. For example, fishers scan the sky for weather and sea condition fronts before deciding to leave port for fishing. There are many words for indicator, *e.g.*, sign, symptom, signal, tip, clue, grade, rank, data, pointer, dial, warning light, instrument, measurement, reference point, among others.

The Convention of Biological Diversity (CBD) used the mean trophic level (MTL) and primary production required (PPR) as among the indicators for the management of sustainable fisheries exploitation and understanding the trophic interactions and how these affect fisheries (Hornborg *et al.*, 2013). Environmental health indicators have been identified to give people the idea of whether the environment is getting better or worse, based on analytical frameworks and models (De Wit *et al.*, 2004). In fisheries, indicators are necessary to enhance communication, transparency, effectiveness, and accountability in natural resource management (FAO, 1999). Indicators could be used in assessing the performance of fisheries policies and management at global, regional, national, and local levels, providing readily understood tools for describing the state of fishery resources and fisheries activity, and for assessing trends regarding sustainable development objectives that could stimulate action to achieve sustainability. Thus, fisheries indicators could be referred to as a practical tool that supports the management of fisheries, provides information on the status and trend of fisheries and resources, and supports decision-making processes (SEAFDEC, 2006).

Indicators have also been increasingly seen as a valuable tool that links policy objectives and sustainable development goals, implying that indicators could include resource, ecological, social, and economic dimensions that support management decisions, fulfilling multiple roles in fisheries systems that could be adapted to a particular use or set of users (FAO, 1999). Given such a background, FAO developed the Guidelines on Indicators for Sustainable Development of Marine Capture Fisheries in 1999, to support the implementation of the Code of Conduct for Responsible Fisheries (CCRF). The Guidelines provide general information on the sustainable development of fisheries to clarify why a system of indicators is needed to monitor the contribution of fisheries to sustainable development, as well as information on the type of indicators and related reference points required (FAO, 1999).

Meanwhile in Southeast Asia, fisheries development has been challenged by various concerns, notably the overexploitation

of the limited resources resulting in the degradation of the fishery resources. To address such concerns, the governments of the countries in the region have committed to support efforts toward sustainable fisheries development and management. In November 2001, the ASEAN Member States (AMSs) adopted the Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region (SEAFDEC, 2001) which was developed with reference to the global CCRF developed by FAO which was subsequently regionalized by SEAFDEC for greater adaptability by the AMSs. Results of the regionalization of the CCRF were a series of publications on Regional Guidelines for Responsible Fisheries in Southeast Asia (SEAFDEC, 2000; SEAFDEC, 2003; SEAFDEC, 2005a; SEAFDEC, 2005b; SEAFDEC, 2006). The Supplementary Guidelines on the Use of Indicators for Sustainable Development and Management of Capture Fisheries in Southeast Asia, which forms part of the Supplementary Guidelines on Co-management Using Group User Rights, Fishery Statistics, Indicators and Fisheries *Refugia* (SEAFDEC, 2006), specifies the need for the AMSs to systematically establish the most critical and proper fisheries indicators and standards for fostering sustainable fisheries management in their respective countries.

Indicators and Fisheries *Refugia*

The nature of fisheries in the region is mainly characterized as tropical small-scale multispecies and multigear fisheries, and the use of indicators for fisheries management in an adaptive manner could be practical and easily understood and supported by stakeholders. Adaptive management is a broad co-management concept, where fishery managers react on indicators to assess fisheries, resources, and ecosystem instead of classical stock assessment (*e.g.* maximum sustainable yield or MSY and maximum economic yield or MEY).

In an effort to address the concerns related to the widespread overexploitation of fish stocks in the waters of Southeast Asia, especially in the South China Sea and Gulf of Thailand, the 2002–2008 UNEP/GEF Project "Reversing Environmental Degradation Trends in the South China Sea and Gulf of Thailand" developed the initial concept of fisheries *refugia* (Pernetta *et al*., 2010). Moreover, the Project which was implemented by SEAFDEC in collaboration with its Member Countries refined the concept and developed a framework for the establishment and operation of a regional system of fisheries *refugia*, targeting priority transboundary, demersal fish, and non-finfish resources (UNEP, 2007). Considering that specific habitats and areas are critically important to different stages of the life cycle of each aquatic species, such areas have to be managed to adopt the concept of fisheries *refugia*. The fisheries *refugia* approach is based on the "ecosystem

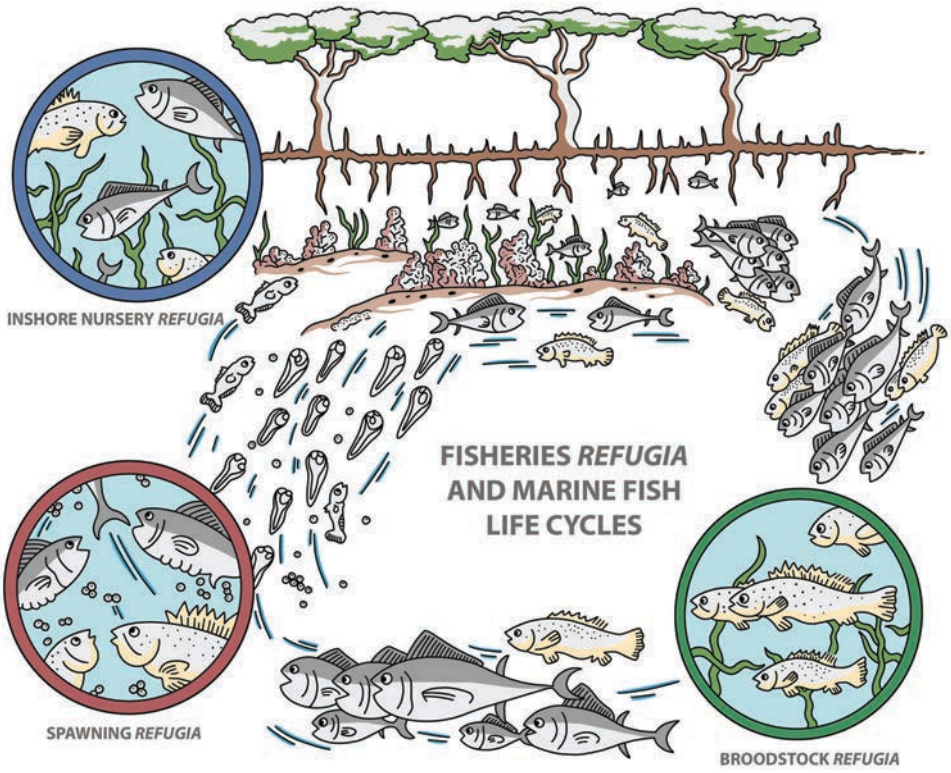


Figure 1. Types of fisheries *refugia* in relation to the generalized life cycle of demersal marine fishes (Pernetta *et al*., 2010)

approach (EA)" concept like many existing approaches, *e.g.* marine spatial planning (MSP), coastal resource management (CRM), co-management, integrated coastal zone management (ICZM). Although fisheries *refugia* share the same principles and have many commonalities with other approaches, management focus or coverage could be different but support each other.

Thus, the fisheries *refugia* concept was developed as a novel fisheries resource management approach to the identification and designation of priority areas in which to integrate fisheries and habitat management in the context of maintaining fish stocks and critical habitats (Paterson *et al*., 2012). In the South China Sea and the Gulf of Thailand, there is a need to develop robust and workable solutions to involve stakeholders in establishing and managing fisheries *refugia*. The diverse traditions and cultures in the Southeast Asian region and the vital role of small-scale, coastal, and subsistence fisheries provided an impetus for the development of fisheries *refugia* approaches to stakeholder participation in the management of fisheries at all levels.

In the Southeast Asian context, fisheries *refugia* is defined by the UNEP/GEF/SCS as "spatially and geographically defined, marine or coastal areas in which specific management measures are applied to sustain important species [fisheries resources] during critical stages of their life cycle, for their sustainable use" (Pernetta *et al*., 2010). Considering the general commonality of understanding that fisheries *refugia* relate to specific areas of significance to the life cycle of particular species, fisheries *refugia* may be defined in space and time to protect spawning aggregations, nursery grounds, and migratory routes (**Figure 1**).

Regional Guidelines on Indicators for Sustainable Management of Fisheries *Refugia*

As of December 2021, the participating countries of the 2017–2022 SEAFDEC/UNEP/GEF Project "Establishment and Operations of a Regional System of Fisheries *Refugia* in the South China Sea and the Gulf of Thailand" have established their respective fishery *refugia* sites (**Box 1**), where fisheries *refugia* management is being effectively implemented and promoted for certain economically important commodities (Siriraksophon, 2022). While the Project activities are in progress, a regional experts' group with members who represent the six participating countries was established in 2019 to brainstorm how the fisheries *refugia* approach adopted by the countries could support the sustainable development of fisheries in the South China Sea, including the kinds of information and indicators that would be needed to address the issues and concerns (SEAFDEC, 2022).

The progress of the Project activities in the six participating countries, especially the experiences and lessons learned

Box 1. Established fisheries *refugia* under the 2017–2022 SEAFDEC/UNEP/GEF Project	
Cambodia	• Blue swimming crab *refugia* in Koh Po and Koh Tonsay Archipelago, Kep Province • Indo-Pacific mackerel *refugia* in Peam Krasob, Koh Kong Province • Grouper *refugia* in Prek Thnaot, Kampot Province
Indonesia	• Mitre squid *refugia* in Bangka Belitung Province • Indian white shrimp *refugia* in West Kalimantan Province
Malaysia	• Spiny lobster *refugia* in Tanjung Leman, Johor State • Tiger prawn *refugia* in Miri, Sarawak State
Philippines	• Bolinao *refugia* site at Bolinao coastal area in Pangasinan Province for siganid species • Masinloc *refugia* site at Masinloc coastal area in Zambales Province) for *Auxis thazard* (frigate tuna or 'tulingan'), *Pterocaesio tessellata* (one-stripe fusilier or 'terong'), and *Sardinella fimbriata* (fringe scale sardine or 'bilis') • Coron *refugia* site off Coron Islands, Palawan Province for *Caesio cunning* (red-belly yellowtail fusilier) and *Decapterus maruadsi* (white-tipped scad)
Thailand	• Indo-pacific mackerel *refugia* off Trat Province • Blue swimming crab *refugia* around Koh Sed, Surat Thani Province
Viet Nam	• Spiny lobster and shark *refugia* off Bach Long Vi Island, Viet Nam • Spiny lobster and Japanese eel *refugia* off Con Dao Islannd, Viet Nam

from the establishment of fisheries *refugia*, the challenges and issues encountered as well as the achievements attained so far were referred to during the discussion which was aimed at coming up with the Regional Guidelines on Indicators for Sustainable Management of Fisheries *Refugia*.

Considering that the South China Sea area has been subjected to high and increasing levels of fishing pressure, the regional experts' group defined the structural framework for enhancing the effective sustainable management of fisheries *refugia* which included four dimensions comprising twelve targets (**Figure 2**). Moreover, the corresponding indicators and criteria for the sustainable management of the fisheries *refugia* had also been identified (**Box 2**) (SEAFDEC, 2022).

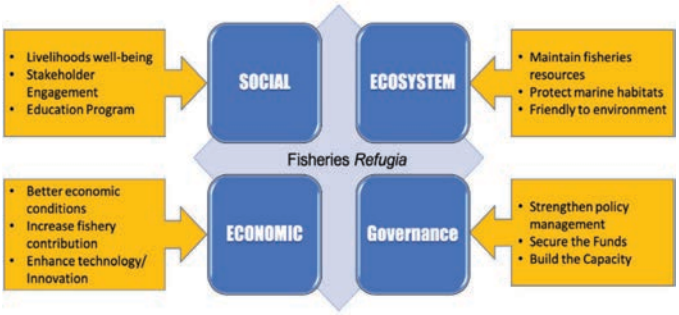


Figure 2. Structural framework for enhancing the effective sustainable management of fisheries *refugia*

Box 2. Structural framework for enhancing the effective sustainable management of fisheries *refugia*			
Dimension	Target	Criteria	Indicator
Ecosystem	Fisheries resources are preserved and maintained	• Abundant stock/fishing effort • Biological parameter • Catch structure	• Biomass estimation (MSY, MEY, CPUE, CPUA, catch, Lc, Lm, sex ratio, SPR, length frequency, exploitation rate, gonadosomatic index, dominant species, number of species, main economic/commercial species, bycatch composition)
	Marine habitats are protected	• Health • Condition • Area	• Size coverage, habitat health index, target habitat density (IUCN reference)
	Fisheries practices are friendly to the environment	• Pollution • Eutrophication • Anthropogenic (human activity) • Erosion	• Standard water quality (COD, BOD) • Phytoplankton abundance, phosphate, nitrate concentration (nutrient load) • Coastal reclamation area • Level of maritime activity • Level and distribution of sedimentation • Loss of habitat
Social	Livelihood opportunities are generated for the well-being of stakeholders	• Choice of occupation • Fish consumption • Nutrition	• Number of options, occupation, work (alternative, permanent, or subsistence) • Fish consumption per capita per year • Percent animal protein (if appropriate)
	Stakeholders' engagement is enhanced	• Participation • Local organization • Networking	• Ratio of number of participations (gender and IP) • Number of organizations • Number of best practices applied • Number of networking • Type/way of direct or indirect communication • Number of agreements

Box 2. Structural framework for enhancing the effective sustainable management of fisheries *refugia (Cont'd)*			
Dimension	Target	Criteria	Indicator
	Education programs are developed and promoted for all stakeholders	• Awareness program (*e.g.* information center, information education campaign) • Capacity building	• Number of information centers • Number of consultations • Number of best practices, • Number of awareness programs • Number of understandings by stakeholders • Number of training/extensions
Economic	Economic conditions of communities are improved	• Poverty incidence • Capital accessibility • Income	• Poverty Index • Multidimensional poverty index • Number of accessible financial services • Income per household
	Contribution of fisheries to the economy is improved due to increased production	• Contribution of target species and availability	• Value of contribution or production
	Promotion of fisheries technology innovations are enhanced	• Effectiveness of fishing gear • Cost-effectiveness • Environment-friendly (green technology) • Investment	• Level of CPUE • Cost reduction, time, human power • Reduced fuel consumption • Reduced bycatch • Number of investments, fishing fleet, processing, ship builder, management tools/software, new domestic products
Governance	Fisheries management policies are strengthened at all levels	• Management mechanism • Coordination mechanism • Fishery Law enforcement	• Management board/committee, transboundary committee • RPOA for *refugia* in place • Linkage to the existing management/ conservation framework (*e.g.* MPAs) • Inter-agency coordination in place • Number of joint operations • Level of enforcement • Frequency of regular patrol • Number of violation prosecution
	Funds are secured for infrastructures, enforcement, and relevant operating costs	• Sustainability • Source of funding (incentive, soft loan, donations, corporate social responsibility) • Incentives	• Long-term commitment of the government to finance • Number of donors • Type of funds • Type and number of incentives • Number of activities • Number of best practices
	Capacity of stakeholders is built and/ or enhanced	• Best practices • Maritime policy and regulation, international policies	• Adoption of best practices in place • Number of training/workshops

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About the Author

Dr. Somboon Siriraksophon is the Project Manager of the SEAFDEC/UNEP/GEF Project "Establishment and Operation of a Regional System of Fisheries *Refugia* in the South China Sea and Gulf of Thailand." Email: ssiriraksophon63@gmail.com.

Enhancing the Reproductive Performance of Cultured Shrimp: novel information on scent, maturation, and mating

Sheryll S. Santander-Avanceña

What are sex pheromones and how do they function in the courtship and mating of shrimps and other crustaceans? Best known as chemical compounds excreted by animals to initiate reproduction-related responses from their potential mates, pheromones became an important factor in shrimp culture. An earlier study, showed that the domesticated shrimp had a reduced level of pursuit behavior than the wild-caught and suggested that sex pheromones could have played a role in this behavioral difference. Domesticated penaeids are typically reared communally until ready for use as broodstock wherein animals are continually exposed to varying chemical cues. There is a close relationship between chemicals involved in molting and mating of closed thelycum species but information regarding the effect of prolonged exposure of male penaeids to molting and sex pheromones of females on reproduction behavior is not available.

In 2021, SEAFDEC/AQD conducted a research to evaluate the possible implications of monosex rearing on gonad maturation and reproduction behavior of *Penaeus indicus* broodstock. Results demonstrated that the traditional communal rearing of male and female *P. indicus* broodstock do not have a significant effect on the ovary development and sperm quality of female and male broodstock, respectively. But this common practice of rearing male and female broodstock together significantly reduced reproductive related behavior leading to lower successful matings compared to when broodstock were reared monosex. This novel information could be linked to previous report on reduced successful matings previously reported in black tiger prawn, *P. monodon*. Therefore, monosex rearing should be considered as an alternate broodstock setup as this will facilitate optimized sex-specific nutritional manipulation and even potentially increase the mating success of domesticated penaeid broodstock.

Shrimp is the most traded aquaculture commodity and is considered a significant contributor to world aquaculture production. The shrimp industry is projected to expand another 50 % in its production; however, disease outbreaks continue to threaten the industry across the globe. Different approaches were carried out to address this problem, including closing the life cycle in captivity and domesticating the commodity.

However, wild-caught broodstock is a known vector of pathogens and using wild animals in the hatchery phase was reported as the culprit of introducing pathogens to production systems. Addressing this issue would not only prevent the risk of pathogen introduction from wild-caught broodstock but also ensure a steady supply of high-quality larvae. Most importantly, the foundation of high-quality domesticated broodstock is a prerequisite for developing pathogen-free broodstock which will lead to genetically better culture lines in the future.

Domestication of some penaeid species resulted in poor broodstock reproductive performance as compared to wild-caught. Females gathered from the wild matured and reproduced more quickly and frequently than domesticated females after ablation (Coman *et al*., 2006). Subsequently, wild-caught females were also said to produce more eggs than domesticated broodstock (Menasveta *et al*., 1993; Arnold *et al*., 2013). Furthermore, the domestication of black tiger prawn (*Penaeus monodon*) resulted in poorer reproductive performance than that of the wild-caught due to relatively low mating success in domesticated broodstock. An earlier study showed that the domesticated shrimp had a reduced level of pursuit behavior than the wild-caught and suggested that sex pheromones could have played a role in this behavioral difference (Marsden *et al*., 2013).

A breeding program would usually start by collecting wild species of interest, growing them in tank systems, closing the life cycle in captivity, and domesticating several generations to develop culture lines with superior growth, improved disease resistance, and prolific reproduction. The black tiger prawn used to dominate global shrimp production; however, disease outbreaks and difficulty in domestication prompted the shift to alternate species.

Sex pheromones, the shrimp scent for mating

Pheromones are chemical messages that an individual secretes to elicit a behavioral reaction or an endocrine change in another individual of the same species (Altstein, 2013). In addition, sex pheromones are chemical compounds released by animals to communicate many critical life-cycle processes, such as locating conspecifics, recognizing another individual as potential mates, and orienting various body parts for effective sperm transfer during reproduction (Caskey and Bauer, 2005; Snell *et al*., 1995). In short, sex pheromones are like scents that are released by the females to advertise its readiness to mate, its location, and its body orientation.

These chemical cues were reported to have evolved from substances leaked from sexually mature adults or released along with eggs or sperm stored in the body cavity. The exchange of small quantities of egg and sperm coupled with its respective chemical cues leads the female to release her eggs together with a large amount of pheromones to prompt the male to release a substantial amount of sperm into the

eggs (Wyatt, 2014). Pheromones are generally identified as proteins and peptides which co-opted from molecules with other functions. The blend of these chemicals changes along with the divergence or convergence of species, such as that related species would differ by just two amino acids (Rittschof & Cohen, 2004).

To better understand what causes the poor mating success in the domesticated *P. monodon*, the study of Marsden *et al*., (2013) clarified whether differences exist in mating behavior and hence mating success between wild-caught and domesticated *P. monodon* broodstock. Matings were observed only involving pairings where the female originated from the wild and not when females were domesticated, and molted females were pursued more vigorously by wild line males than domesticated line males. Specifically, wild line males spent more time "under" newly molted females than domesticated line males. Likewise, wild line females more often had males "under" them than domesticated line females. This reduced engagement in courtship and mating rituals which led to reduced mate recognition could create a big impact on the overall reproductive success of *P. monodon* in hatcheries. It was speculated that the shrimp's reduced level of pursuit behavior was probably due to the smaller amount of ineffective pheromones produced by the domesticated female shrimp. It may also be that the domesticated males have a reduced ability to detect or process the chemicals compared to their wild-caught counterparts.

Nutritional requirements of male and female Penaeid broodstock

Nutritional manipulation is one of the most sought interventions to improve the reproductive performance of domesticated broodstock. Researchers examined the effects of different food formulations and diet combinations on vitellogenesis and vitellogenin levels, biochemical composition, spawning success, and fecundity. However, there is a lack of study on the effects of these dietary interventions on male shrimp species. Maturation diets that were optimized to promote female maturation were the same feed provided for male broodstock. This is despite reports on some crustaceans showing variances in the nutrient requirements of males and females for growth. Similarly, the kind and amount of nutrients required by male and female broodstock may also vary since each broodstock undergoes different physiological and behavioral processes to successfully reproduce.

Female shrimp invests energy in the accumulation of yolk protein during vitellogenesis, which is subsequently utilized during embryogenesis and early larval development of the offspring. For instance, a fully mature ovary of a female penaeid such as Indian white prawn *P. indicus* weighs up to 6.00 % of the total body weight. Meanwhile, for males, reports showed that mature spermatophore could only weigh as much as 0.12 % of body weight based on a 20–30 g *P. stylirostris* (Alfaro, 1993) and up to 0.64 % of body weight for *P. indicus* (Santander-Avanceña, 2021). For males, reproductive energy investments were spent on reproductive-related behavior such as mate searching and courting, which were guided by different cues. These variances in the gonadosomatic indices and demand for energy during mating between male and female penaeids could have implications in the respective nutritional requirements of male and female broodstock.

For efficient shrimp broodstock maturation, polychaete is an indispensable diet. But what is in the polychaete that specifically promotes ovarian development and sperm production? Santander-Avanceña *et al*. (in press) tested the most efficient polychaete component in promoting female and male penaeid maturation. Mud polychaete (*Marphysa* sp.) was used in the research and the extract was fractionated into a total soluble fraction (TSF), neutral lipid fraction (NLF), and polar lipid fraction (PLF). The study was conducted on the Indian white prawn, a commercially important closed thelycum penaeid species indigenous to the Philippines. The broodstock, *P. indicus* was fed with an artificial maturation diet with polychaete extract fraction supplemented at different inclusion levels (0.25 %, 0.50 %, and 1.00 %) following a 3 × 3 factorial design. The study was conducted using 500-L tanks, and a total of 33 units of tanks were used for females and another set of 33 tanks for the male study (**Figure 1**).

Figure 1. 500-L tanks used in the experiment to test the most efficient polychaete extract fraction in promoting male and female gonad maturation

It is widely known that polychaete is regarded as the best maturation diet because of its high content of highly unsaturated fatty acids and reproductive hormones. Results confirmed the efficiency of NLF to enhance gonad maturation with at least a 0.50 % inclusion level. It was also proven that other fractions such as TSF containing protein and peptide precipitates and PLF containing phospholipids can equally promote maturation (**Figure 2**). This study also demonstrated the efficiency of supplementing polychaete phospholipids in promoting vitellogenesis of *P. indicus*. This fraction promoted

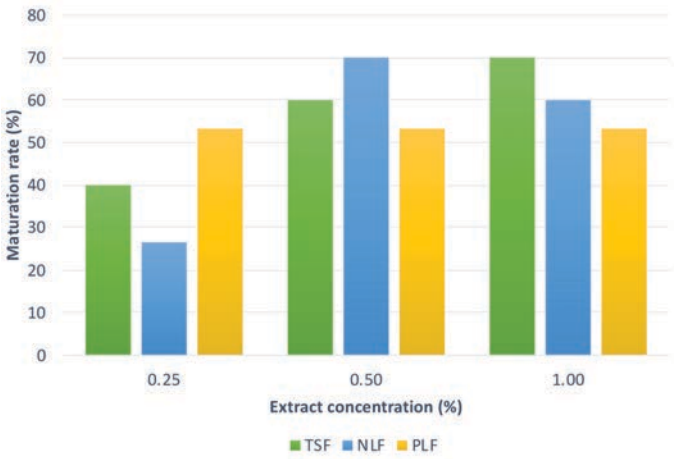

Figure 2. Maturation rate (%) of female *P. indicus* broodstock fed maturation diet supplemented with different polychaete extracts at varying inclusion levels *(**TSF:** total soluble fraction, **NLF:** neutral lipid fraction, **PLF:** polar lipid fraction)*

the gonad maturation in the greatest number of female broodstock and the highest relative expression vitellogenin ovarian gene at the lowest inclusion level (0.25 %). Real-time PCR analysis of vg transcripts in ovaries of *P. indicus* broodstock showed similar levels of gene expression for all treatments (1.02–1.93) except for the group fed with a maturation diet supplemented with 0.25 % and 0.50 % polar lipid fraction where vg expression is approximately four-fold higher. However, this maturation promotion effect of PLF was not consistent with the male *P. indicus* broodstock since PLF extract supplementation resulted in lower sperm counts of broodstock compared to that fed supplemented with TSF and NLF.

It is also noteworthy that the provision of a well-formulated diet without polychaete supplementation resulted in similar maturation rate sperm quality, highlighting the differences in the nutritional demands of male and female broodstock during maturation. Such variation in the nutritional requirement in terms of growth of male and female were also reported for other crustaceans such as those for *P. monodon* (Hansford & Hewitt, 1994) and *Eriocheir sinensis* (Zhu *et al*., 2021). Hence, sex-specific nutritional manipulation can be performed to address the precise needs of male and female broodstock.

Maturation and mating: a match between naive and conditioned broodstock

Shrimp hatcheries would typically rear males and females in communal tanks until mature and ready to be used as broodstock. On the other hand, the effects of rearing hatchery-produced broodstock separately, known as monosex, on reproductive performance are unknown. The possible implications of separate rearing on gonad maturation and the reproduction-related behavior of *P. indicus* broodstock were evaluated by Santander-Avanceña *et al*. (2022).

Ovarian maturation and sperm development of communally reared (conditioned) and separately reared (naive) male and female broodstock were monitored for one month (**Figure 3**). Conditioned broodstock are the broodstock from the communally reared group, while naive broodstock refers to the test animals grown separately after secondary sexual identifications were visible. The broodstock used was the same batch of post-larvae divided into different treatment groups after secondary sexual organs were visible. The conditioned broodstock was previously exposed to molting hormones and sex pheromones released by counterparts since stocking in tanks.

Figure 3. A *P. indicus* female broodstock with mature ovary *(left)* and male broodstock with developed spermatophore *(right)*

Based on daily monitoring of gonad development, results showed a higher percentage of female broodstock reared with males developing mature ovaries, but the difference was insignificant. Similarly, it only took seven days for communally raised females to develop mature gonads compared to those reared in all-female tanks, around 11 days, but the difference was not significant. A previous report on caridean shrimp (*Neocaridina davidi*) showed male presence did not enhance the percentage of mature females in caridean shrimp (Tropea *et al*., 2018), but it successfully boosted ovary sizes. The maturation rate and latency duration were likewise higher in conditioned females in the current investigation, but the stimulatory effect of pheromones was not significant.

This finding suggests that other factors have far more significant impacts on vitellogenesis than the stimulus provided by male counterparts. Eyestalk ablation was performed on female broodstock from both treatments. In the process of removing the eyestalk, vitellogenesis-inhibiting hormone was removed, and the release of gonad-stimulating factor was stimulated (Wongsawang *et al*., 2005). Furthermore, the nutritional levels in both treatments' diets were previously suited for *P. indicus* maturation, which could have helped gonad maturation (Santander-Avanceña *et al*., 2020).

Regarding males, growing the broodstock either in monosex tanks or communally with females did not significantly impact the percentage of males developing mature sperm nor affected the interspermatophore period or the number of days elapsed for the broodstock to develop mature sperm. The quality of sperm was also not affected by the different rearing methods,

specifically, the sperm counts, percent viability, and percent abnormality values were similar between the two groups. Currently, there is no data available on the influence of female presence on male penaeid maturation. Similarly, the presence of females did not influence the sperm production of rainbow trout, *Salmo gairdneri* (Büyükhatipoglu & Holtz, 1984). According to research, male guppy *Poecilia reticulata* coupled with a female for one week had more strippable sperm (Bozynski & Liley, 2003). Male *Macrobrachium rosenbergii* prawns cocultured with late premolt to early postmolt females had significantly increased gonad maturation (Kruangkum *et al*., 2019). Sperm decrease was also observed in other creatures due to the absence of females or reduced exposure to females (Bjork *et al*., 2007; Demas & Nelson, 1998; Wedell *et al*., 2006). The sperm count and quality recorded in this study were within the range of sperm counts previously published for penaeid species, implying that sperm development did not require exposure to females if the nutritional requirements of the male broodstock were met.

Mating behavioral differences between naive and conditioned broodstock were also compared using the same broodstock set. Daily monitoring was done to identify premolt females. Penaeid shrimps, such as *P. indicus*, are closed thylecum species and can only mate if it is in the molt stage. During that stage, sex pheromones are released by females to signal the male counterpart the readiness to mate. The identified premolt females were transferred to 100-L glass aquaria and paired with two intermolt males or hardshell broodstock. Each aquarium was equipped with cameras for overnight video surveillance. Red lighting was also provided to improve visibility but will not disturb the activities of the animals (**Figure 4**).

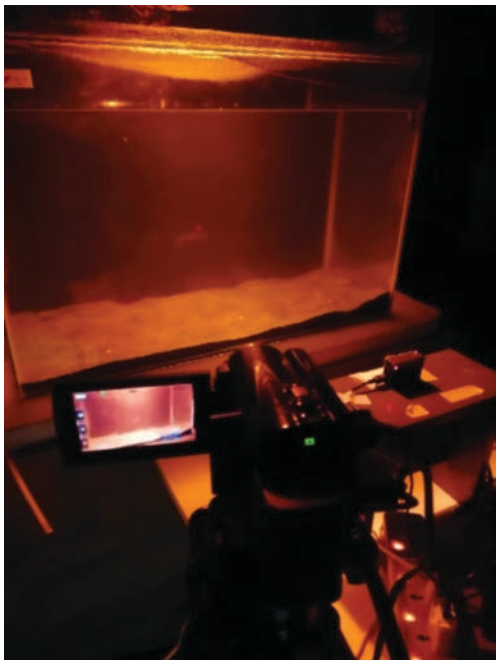

Figure 4. Reproductive-related behavior and mating of naive and conditioned *P. indicus* broodstock were observed in a 100-L glass aquarium for overnight video surveillance equipped with red lights and cameras

Reproductive behaviors were assessed based on the total counts of the two males touching discarded molt (touch), fighting with another male (fight), chasing the female (chase), and advancing to a probing position (probe) where the male was swimming under the female (Marsden *et al*., 2013). The number of times a male fought with another male was also counted. The sum of all reproduction-related behaviors was compared for the two treatments. Activities were noted and analyzed within 30 min of molting (Marsden *et al*., 2013). Some reproductive behaviors assessed are shown in **Figure 5**.

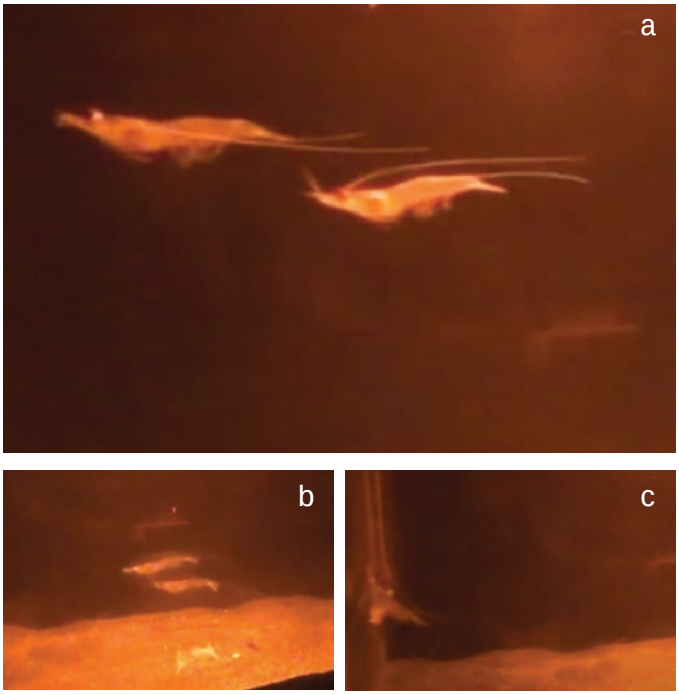

Figure 5. Reproductive-related behavior of *P. indicus* broodstock towards successful mating *(**a:** male broodtstock chased a newly molted female; **b:** advanced to probing position; **c:** a male curved its body perpendicular to female and flexed its head and tail simultaneously to deposit sperm)*

Results showed that males from the two groups had statistically significant differences in initiated chase and fight, with the naive males recording more chase and fight counts than the conditioned males. Naive males were also more likely to advance to the probing position and touch a discarded molt than conditioned males, although the differences were not significant (**Figure 6**). No significant difference was detected in the counts of probe and touch between naive and conditioned males but significant differences in the occurrences of chase, fight, and sum were determined.

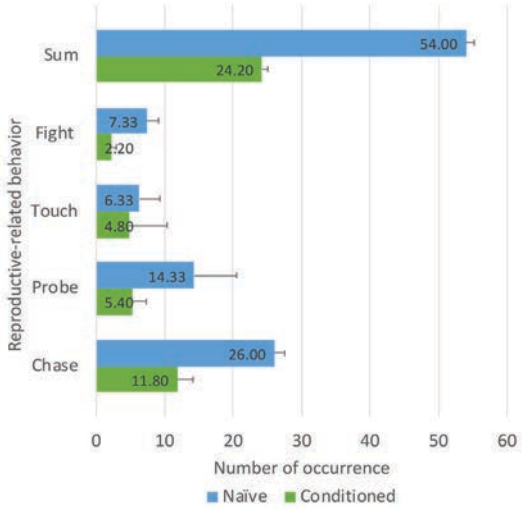

Figure 6. Number of occurrence of different reproductive-related behaviors initiated by naive and conditioned male *P. indicus* broodstock toward a newly-molted female (***sum*** *is the total of all reproductive behaviors initiated by males)*

The analysis of the sum of total reproductive-related behavior showed that naive males initiated considerably more activities (54.00) than conditioned males (24.20) (**Figure 7**). Animals generate sex pheromones to convey numerous crucial life-cycle events. Detection of this chemical cue is vital for closed thylecum species to secure a mating partner during the limited time the female is in the molt stage. Males that were raised away from females exhibited higher reproductive behavior than conditioned males. Constant exposure to molting females and their accompanying sex pheromones might have affected the male identification of molting females. However, no data on the effect of continual exposure on penaeid reproductive behavior is available.

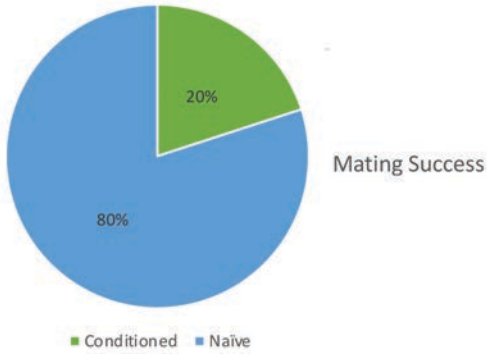

Figure 7. Ratio of successful mating (%) observed between the naive and conditioned *P. indicus* broodstock

Nonetheless, insects have been observed to have different sensitivities to sex pheromones. Pre-exposure to sex pheromones in nuisance insects like *Copitarsia decolora* and *Grapholita molesta* inhibited the olfactory response, lowering attractiveness during mate finding, and delaying mating (Figueredo and Baker, 1992; Robledo *et al*., 2018). While this condition is used to manage pests, it will have a negative impact on the reproductive performance of economically significant penaeids like *P. indicus*. Furthermore, the initial results on the effect of the rearing strategy on mating revealed a 60 % difference in successful mating between naive and conditioned.

According to Okumura (2004), there is no clear connection between vitellogenesis and the molt cycle. However, because molting is required for closed thelycum female species like *P. indicus* and *P. monodon* to mate (Primavera, 1985), the emission of sex pheromones may occur during premolt stage of domesticated shrimp, especially when ecdysteroid levels are at their highest (Okumura, 2004). The desensitization to sex pheromones noted in insects could be the same condition that happened in the conditioned *P. indicus* broodstock. The reduced initiation of reproductive related behavior in conditioned male broodstock group which lead to low successful mating could be due to prolonged exposure to mate inducing scents or sex pheromones. While the concept of desensitization is utilize in agriculture to control the population of pests, this could have a negative implication in shrimp aquaculture.

Conclusion and Way Forward

This is the first study to report the effects of extended exposure of male penaeids to female molting and sex pheromones on reproductive behavior. The study also showed that the traditional practice in hatcheries of communal rearing male and female penaeids did not negatively impact gonad maturation but may still affect overall reproductive output by reducing the broodstock reproductive behavior. This novel information can be possibly linked to the reduced reproductive performance of captive penaeids compared to the wild-caught which is a bottleneck in domesticating the major aquaculture commodity, *P. monodon*.

The use of polychaete extract as a supplement stimulated the development of new tactics for nutritional manipulation of male and female penaeid broodstock. To optimize maturation and mating, communal stocking of male and female broodstock until suitable for use should be re-evaluated. The present study on the effects of communal versus individual broodstock rearing on maturity and reproductive behavior demonstrated that growing monosex or co-cultured broodstock did not affect maturation and sperm production and quality of shrimps – it can even improve reproductive behavior and mating success. These findings point to the possibility of a nutritional intervention tailored for male and female broodstock.

As a former major producer of black tiger prawn and since it is indigenous to the Philippines, it would be of great interest for the country and valuable for the scientific community to know if indeed the failing pheromones, low production and failure in detection, played a key role in the reduced reproductive

output of domesticated stocks of the species. Answering this knowledge gap could be the linked to regain the glorious days of the Philippine prawn industry.

Isolation and identification of sex pheromones used by crustacean is a challenging research endeavor as suggested by the limited scientific output in this line of work. However, pheromones specifically sex pheromones play a significant role in an organism's successful reproductive performance and possible application in aquaculture especially in breeding will be a big lift to the industry. To be able to determine receptive females whose mating and spawning are fairly synchronized would be useful for hatchery operations. This would allow holding synchronized females together that would populate the spawning tank with postlarvae which are uniform in age and size.

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About the Author

Dr. Sheryll Santander-Avanceña is a scientist at SEAFDEC/AQD assigned at its Tigbauan Main Station in Iloilo, Philippines. She finished her Ph.D. from from the Institute of Aquaculture, College of Fisheries and Ocean Sciences, University of the Philippines Visayas in Miagao, Iloilo, Philippines. Her study entitled "The influence of monosex rearing on gonad maturation and reproductive behavior of Indian white prawn, *Penaeus indicus* broodstock" originally appeared in the 15 April 2022 issue of Aquaculture (Vol. 552). Meanwhile, the study on the effect of polychaete extracts on shrimp gonad maturation is currently in press as "Evaluation of maturation promoting factor in polychaete (*Marphysa* sp.) on Indian white prawn, *Penaeus indicus* female broodstock" in the journal Aquaculture Research.

Reviving the Giant Featherback (*Chitala lopis*) in Indonesia

Zulkarnaen Fahmi, Dina Muthmainnah, Edy Januari Utama, Sevi Sawestri, and *Siti Rachmi Indahsari*

In Indonesia, the giant featherback (*Chitala lopis*) is an economically important freshwater fish. However, this fish has been overfished due to its high demand. For the sustainability of the fishery resource, the Government of Indonesia issued the Decree of MMAF No. 1/2021 declaring this fish species fully protected. Currently, the Research Institute for Inland Fisheries and Extension (RIIFE) with support from the PT Kilang Pertamina Internasional Refinery Unit III Plaju is carrying out experiments on the culture of the giant featherback to revive the population of the giant featherback in the country.

The family Notopteridae includes 10 species of osteoglossiform (bony-tongued) fishes, namely: the reticulated knifefish (*Papyrocranusafer* (Günther, 1868)); African knifefish (*Papyrocranus congoensis* (Nichols & La Monte, 1932), *Xenomystus nigri* (Günther, 1868)); royal knifefish or Indochina featherback (*Chitala blanci* (d'Aubenton, 1965)); Indonesian featherback (*Chitala borneensis* (Bleeker, 1851)); Indian featherback (*Chitala chitala* (Hamilton, 1822)); giant featherback or clown knifefish (*Chitala hypselonotus* (Bleeker, 1852), *Chitala lopis* (Bleeker, 1851), *Chitala ornata* (Gray, 1831)); and the bronze featherback (*Notopterus notopterus* (Pallas, 1769)).

Focusing on *Chitala lopis* or giant featherback, this fish species is found in the Mekong Basin and several Southeast Asian countries, particularly Cambodia, Indonesia, Malaysia, and Thailand (Kottelat *et al*., 1993) (**Figure 1**). It is called "trey krai" or "trey slat" in Cambodia, "ikan belida" in Perak, Malaysia, or "pla satu" in Thailand. In Indonesia, this fish is distributed in Riau, Jambi, South Sumatra, Bengkulu, Lampung, Java, and Kalimantan, and it is locally called "belida" or "belido" in Palembang or "pipih" in Kalimantan.

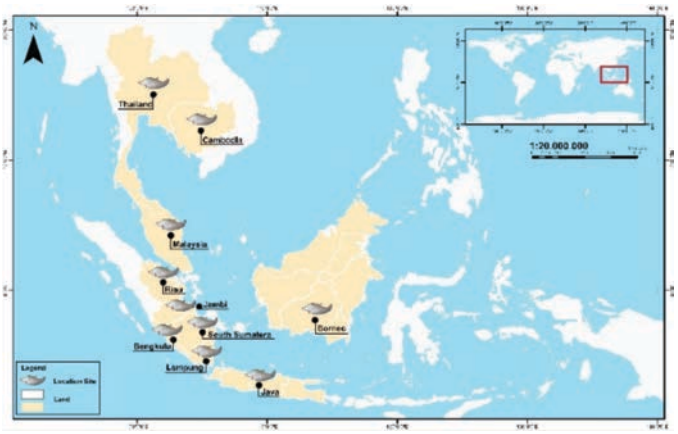

Figure 1. Distribution of giant featherback in Southeast Asia

The giant featherback usually inhabits the lowland river mainstreams and tributaries with rocky and sunken wood bottoms and forest-covered streams. The timbers and logs are refuge areas for small fishes, shrimps, and aquatic insects which are the food source for the giant featherback mostly at night. Besides, the woods or logs serve as substrates for laying their fertilized eggs. During the dry season, they live in the river; and as the water level decreases, they swim to swamps and rice fields for spawning and feeding during the rainy season (Makmur *et al*., 2008).

Figure 2. Giant featherback (*Chitala lopis*)
(Photo: RIIFE)

As shown in **Figure 2**, the jaw of *C. lopis* increases in length throughout its life, extending far beyond the posterior margin of the eye in large specimens. The small juvenile has slightly oblique bars on its body and anal fin; while in larger juveniles and adults, the body is plain and silvery to bronze overall in their life (Kottelat, 2001).

The giant featherback is a popular freshwater fish and has a high economic value in Indonesia. This fish is a symbol of culture in Sumatra and Kalimantan where it is considered as a prestigious food fish for its high protein and vitamin A content. Its flesh has a smooth texture with distinctive taste and it is also widely consumed as fish cake or "pempek" and fish crackers or "kemplang." This fish is also a favorite species for ornamental fish collectors because of its peculiar body shape.

Figure 3 shows the production trend between 2010 and 2017 in the provinces where *C. lopis* is found. During the eight-year period, the average production was 2,985 t with highest in 2014 (4,414 t) and lowest in 2016 (1,380 t). A significant decrease in production was observed from 2015 (2,408 t) to 2016 (1,380 t), although there was a slight increase in 2017 (1,632 t). Among the provinces, the three highest average production were in West Kalimantan (807 t), Central Kalimantan (803 t), and South Kalimantan (538 t).

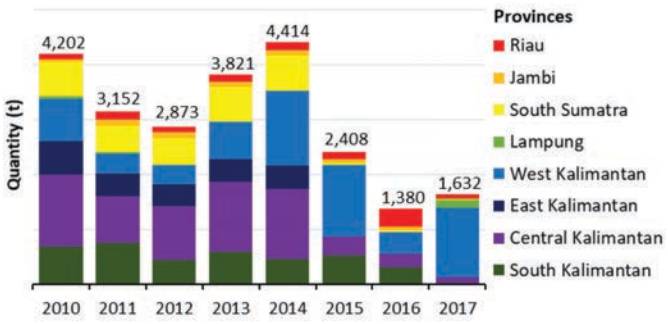

Figure 3. Giant featherback production (t) in 2010–2018 *(KKP, 2022)*

Conservation Efforts

Unfortunately, the production of *C. lopis* was only from the wild. The population of this species had decreased due to overfishing to supply the high demand, use of unfriendly fishing gear, and destruction of habitat. The International Union for Conservation of Nature (IUCN) listed *C. lopis* as extinct in 2019 (Ng, 2019). Therefore, the need to develop sustainable fish farming is crucial for the optimal production of *C. lopis*.

In order to conserve the giant featherback fishery resource, this fish was protected through Government Rule No. 7/1999 while the Conservation Assessment and Management Plan (CAMP) categorized *Chitala* spp., especially *C. lopis*, as a rare species (Sarkar *et al*., 2008). Moreover, through the Ministry of Environment and Forestry, Indonesia applied a new rule in 2018 to protect the four species, namely: *C. borneensis*, *C. hypselonotus*, *C. lopis*), and *Notopterus notopterus*. Strengthening the previous Decree, the Decree of Ministry of Maritime Affairs and Fisheries of the Republic of Indonesia (MMAF) No. 1/2021 was issued to declare the four fish species as fully protected and the capture and utilization of this fish is limited.

In Palembang, the capital city of South Sumatra Province, the giant featherback has served as a mascot. As an effort to raise the awareness of the people of the scarcity of giant featherback in the Musi River, the Palembang City government constructed in 2017 a 12 m × 22 m giant featherback monument in the Kuto Besak Fort Plaza of Palembang with the head of the fish pointing to the Musi River (**Figure 4**). The Mayor of Palembang emphasized that this monument would remind the residents of Palembang that the giant featherback is a native fish in the Musi River. The Indonesian World Records Museum acknowledged the attempt of RIIFE and PT Kilang Pertamina Internasional Refinery Unit III Plaju to promote the conservation the giant featherback. In December 2021, RIIFE bagged the 2nd Best Award for the Innovative Researcher Category from the Governor of South Sumatra Province during the 26th National Technology Awakening Day with the theme "Sustainability of Giant Featherback (*Belida Lanjut Lestari or Belari*)."

In order to reach a wider audience, especially the young people, the South Sumatra Provincial Government through the Regional Research and Development Agency under its program "Podcast One Day, One Innovation" used social media platforms to circulate various innovations to disseminate the information on the giant featherback. Under the Program, RIIFE also conveyed the results of experimental activities on the culture of the giant featherback.

Exploring the Aquaculture Potential

Several studies had been carried out on the giant featherback such as those on resources management (Wibowo *et al*., 2010), seedling technology (Sukendi *et al*., 2019), and

Figure 4. Giant featherback monument in the Kuto Besak Fort Plaza of Palembang City pointing to the Musi River *(Photo: Diana Luspa)*

management strategy for sustainability (Nugroho *et al*., 2020). However, scientific literatures on its culture in captivity are still limited, especially that the cultivation technology on the giant featherback is still complicated, even if its aquaculture plays an important role in maintaining the sustainability of the fishery resource.

Aquaculture technology is one way of bridging the acceleration of conserving the fish stocks in nature. The role of fish farmers is crucial in improving the production of any fishery resource which is one of the keys to optimal utilization and preservation of sustainable resources (Nugroho *et al*., 2020). Currently, the giant featherback is not yet considered an aquaculture commodity, however, attempts to domesticate the fish had been initiated since the early 1980s. Nonetheless, the culture of the giant featherback is still in its development stage and the spawning technology was not yet developed (Sukendi *et al*., 2019).

As the culture of the giant featherback is still at an experimental stage, it is predicted that the farming of this fish is economically unprofitable because of low seed yield. To produce enough seeds in one hatchery run, a number of broodstock would be needed and this is expensive as the price of a broodstock is high. Moreover, as the growth is also sluggish, rearing of the fish would require more feeds. Being carnivorous, farming of the giant featherback has several obstacles that include slow growth, predatory behavior (aggressive), and the need for specific habitat environmental conditions (Sukendi *et al*., 2019; Nugroho *et al*., 2020).

The oil and petrochemical refinery company in Indonesia, PT Kilang Pertamina Internasional Refinery Unit III Plaju, is concerned with community empowerment-based biodiversity programs (Pertamina, 2022). Through its Corporate Social Responsibility (CSR) Program, the Company collaborated with the Research Institute for Inland Fisheries and Extension (RIIFE) to preserve the germplasm of the giant featherback and other native fish species in South Sumatra. The short-term objectives of the two-year (July 2021–July 2023) collaboration include preservation of the germplasm of the giant featherback and selected native fish species in South Sumatra; training and mentoring of community groups for germplasm conservation; and research support through technology dissemination. Meanwhile, the long-term goal is to create a Giant Featherback Farming Village in the Mariana Region, South Sumatra Province.

In the first year of the collaboration, RIIFE has developed several broodstock ponds and hatcheries for the hatchery/nursery of eggs, maintenance of broodstock and larvae, and domestication of *Hemibagrus nemurus* (Asian redtail catfish), *Helostoma temminckii* (kissing gourami), and *Anabas testudineus* (climbing perch). In September 2021, the natural spawning of 66 giant featherback in the ponds was a success; and the effort of RIIFE and PT Kilang Pertamina Internasional Refinery Unit III Plaju was acknowledged with an award from the Indonesian World Records Museum. Furthermore, training on the cultivation of giant featherback and Asian redtail catfish was also organized in 2021 for several groups with assistance from PT Kilang Pertamina Internasional Refinery Unit III Plaju. In early 2022, RIIFE resumed the activities of domesticating the giant featherback, developing of the nursery and semi-artificial spawning technology, and conducting a series of training and mentoring of community groups.

Currently, the domestication process is being carried out to enable the fish to adjust to its new habitat as well as the basic information on the suitability of the habitat and performance of the fish in aquaculture or conservation efforts is being obtained. During the culture trials, the broodstock of giant featherback was fed with snakeskin gourami (*Trichopodus pectoralis*) and small shrimps (**Figure 5**), while the juveniles were fed with artemia, Tubifex, shrimps, and vitamin E. The juveniles were placed in the aquarium with a cylindrical shelter arranged like a pyramid to protect the pups of the seeds as they grow.

Figure 5. Snakeskin gourami *(top)* and small shrimp *(bottom)* as feed for the giant featherback

Aside from addressing the challenges on the conservation of the giant featherback, the relevant community groups would be trained to enhance their knowledge of the cultivation of snakehead (*Channa striata*) and snakeskin gourami which could serve as natural food for the giant featherback. The training would enable the community groups to farm native fish species and reduce feed costs.

Way Forward

Although the Decree of MMAF No. 1/2021 was enacted to limit the capture giant featherback, the Decree of MMAF No. 61/2018 allowed the utilization of the fish for experimental purposes. RIIFE and PT Kilang Pertamina Internasional Refinery Unit III Plaju strive to maintain the public awareness of preserving local fish species by publishing of the results of the experiments on the culture of the giant featherback in various platforms such as scientific journals, popular magazines, newspapers, and others to reach relevant stakeholders. At this juncture, great effort is still necessary to develop the technology of producing giant featherback seeds and keeping them to reach adult stage. Through research, the development of technology on broodstock rearing, spawning, and hatching of giant featherback eggs should be sustained.

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Through the Corporate Social Responsibility (CSR) Program of PT Kilang Pertamina Internasional Refinery Unit III Plaju, the Research Institute for Inland Fisheries and Extension of the Ministry of Marine Affairs and Fisheries, Republic of Indonesia was able to conduct research on the culture of giant featherback in 2021–2022. The authors are also thankful to *Ms. Yenni Sri Mulyan*i for providing the maps for this article.

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About the Authors

Mr. Zulkarnaen Fahmi is the Chief of SEAFDEC/IFRDMD and also the Head of RIIFE, Ministry of Marine Affairs and Fisheries, Republic of Indonesia.

Dr. Dina Muthmainnah is the Special Departmental Coordinator of SEAFDEC/IFRDMD and officer of RIIFE.

Mr. Edy Januari Utama is the General Manager of PT Kilang Pertamina Internasional Refinery Unit III Plaju.

Ms. Sevi Sawestri is the officer of SEAFDEC/IFRDMD and at RIIFE.

Ms. Siti Rachmi Indahsari is the Area Manager Communication, Relations, and CSR RU III of PT Kilang Pertamina Internasional Refinery Unit III Plaju.

Impacts of Lockdowns on Livelihoods of Small-scale Fishers: boon or bane?

Leilani Chavez, Keith Anthony Fabro, Falahi Mubarok, M Ambari, and *Basten Gokkon*

In an attempt to arrest the spread of the novel coronavirus, the Philippine Government began 15 March 2020 lockdown measures in the whole country by putting many provinces in a state of "community quarantine." This move involved a ban on land, air, and sea travel in and out of the country. While the lockdown was intended for one month only, this was extended based on the recommendation of the country's Inter-Agency Task Force (IATF) for the Management of Emerging Infectious Diseases. The lockdown covered all domestic movements, including fishing activities. Until now, lockdowns continued but in varying degrees of coverage, nature, and duration, a move that impacted the fisheries sector, particularly small-scale fisheries. In neighboring Indonesia, local quarantines started in March 2020 and it limited the movement of people. At the end of Ramadan in late May, the government allowed air, land, and sea travel provided people follow "health protocols" as people moved from the capital city of Jakarta go home to the provinces. After the holidays, the country again imposed lockdowns and restricted the movements of people, including fisheries-related activities. The impacts of the government-imposed lockdowns on the fisheries sector of two major fishing nations of Southeast Asia, whether positive or negative, were compiled by Mongabay correspondents from the Philippines and Indonesia.

The Philippines and Indonesia are among the major fish-producing countries in Southeast Asia. Statistical data and information have shown that these countries have significant contributions to the region's total fisheries production, especially during the past five years, *i.e.* from 2014 to 2018. Specifically in 2018, Indonesia contributed the highest production volume accounting for more than 49 % of the total fisheries production in the region while the Philippines contributed about 10 % (Southeast Asian Fisheries Development Center, 2020). In terms of value, Indonesia also contributed the highest at almost 60 %, while the Philippines provided about 10 %, as shown in the following **Table**. However, the COVID-19 pandemic resulted in lockdowns in many countries in Southeast Asia, severely affecting the region's economic sectors including fisheries, and especially hitting hard the small-scale fisheries (FAO, 2021).

Illegal fishing on the rise

Under the Philippine Fisheries Code of 1998, *municipal waters include not only streams, lakes, inland bodies of water and tidal waters within the municipality which are not included within the protected areas as defined under Republic Act No. 7586 (The NIPAS Law), public forest, timber lands, forest reserves or fishery reserves, but also marine waters included between two (2) lines drawn perpendicular to the general coastline from points where the boundary lines of the municipality touch the sea at low tide and a third line parallel with the general coastline including offshore islands and fifteen (15) kilometers from such coastline*. This coastal band is restricted to small-scale fishing, to protect the coral reefs and marine habitats that thrive there. In 2015, the Philippine Government-issued legislation mandating the use of the

Table. Fisheries production of Indonesia and Philippines in 2014-2018 by quantity (million t) and value (USD billion) (SEAFDEC, 2020; FAO, 2020)

	Quantity (million t)					Value (USD billion)				
	2014	2015	2016	2017	2018	2014	2015	2016	2017	2018
Indonesia										
Marine capture fisheries	6.0	6.1	6.1	6.3	6.6	8.0	8.0	8.4	13.2	17.6
Inland capture fisheries	0.4	0.5	0.4	0.5	0.6	0.7	0.7	0.8	1.1	1.2
Aquaculture	14.2	15.6	16.7	16.1	15.8	9.5	8.8	10.3	14.0	12.2
Total	**20.6**	**22.2**	**23.2**	**22.9**	**23.0**	**18.2**	**17.5**	**19.5**	**28.3**	**31.0**
Philippines										
Marine capture fisheries	2.1	2.1	2.0	1.9	2.2	2.8	2.7	2.4	2.4	2.6
Inland capture fisheries	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Aquaculture	2.4	2.4	2.2	2.2	2.3	2.1	2.2	2.0	2.0	2.1
Total	**4.7**	**4.7**	**4.4**	**4.3**	**4.7**	**5.1**	**5.1**	**4.6**	**4.6**	**4.9**
Fisheries production: Southeast Asia	**42.1**	**44.9**	**45.3**	**45.5**	**46.5**	**42.7**	**38.8**	**41.2**	**50.6**	**51.8**
Fisheries production: World	**191.1**	**196.6**	**198.9**	**206.4**	**211.9**	-	-	-	-	-

tracking devices on commercial fishing vessels although its implementation continues to be delayed amid opposition from the industry.

The months of March to May are prime fishing season in the Philippines, ahead of the start of the monsoon in July when sailing conditions become difficult. In 2020, the fishing period coincided with the lockdown imposed by the Philippine Government in response to the COVID-19 pandemic, running from March 17 until May 15, during which all land, sea, and air travel was shut down. During the country's lockdown period, the satellite tracking data have shown that illegal fishing appeared to spike as commercial fishers took advantage of reduced patrols to ply coastal waters that they are prohibited from fishing in. In fact, the satellite data indicated a spike in the number of commercial fishing vessels operating in waters within 15 km of the Philippine coast — a zone that is off-limits for commercial fishing. The increase coincided with the peak fishing season and the imposition of a lockdown in response to the COVID-19 pandemic when deployment of marine patrols was reduced due to the lockdowns.

The lockdowns, therefore, did not stop illegal fishing, according to aggregated data from Karagatan Patrol (karagatan means sea), an online reporting platform that is a collaborative effort between the nonprofit group Oceana Philippines and the Philippine League of Municipalities, to counter illegal fishing. The Karagatan Patrol tracks vessels through the visible infrared imaging radiometer suite (VIIRS), a satellite-based tool that detects the high-radiance luring lights used by commercial fishing vessels. On the other hand, most small-scale fishers use underequipped boats with lights that are not powerful enough to be detected by the VIIRS. While VIIRS detection did not automatically mean the presence of illegal fishing activity, the key factor was where the light sources occurred, considering that in the Philippines, commercial fishing is not permitted within 15 km of the coast. These areas, defined as municipal waters, are restricted to small-scale fishing, to protect the coral reefs and marine habitats that thrive there.

In February 2020, before the lockdown began, the VIIRS data showed 3,602 instances of apparent commercial fishing vessels, about 900 per week on average, within municipal waters. In March, when the lockdown was implemented, that number jumped to 5,950, or an average of 1,487 cases a week. In April, the figure was 4,487 for the month, or 1,121 average weekly cases. The first week of May saw a decline in detections with 309 but the figures jumped to 656 in the second week, 9–15 May. When the lockdown was eased, a total of 1,666 detections were made within the municipal waters in the week of 16–22 May 2020. In an interview with *Ms. Gloria Estenzo Ramos*, Oceana Vice President and Head of Oceana Philippines, she said that the excuse of commercial fishing operators found plying in the municipal waters is that they are hiding from high waves. "In reality, they were fishing in

A school of juvenile bigeye trevally (*Caranx sexfasciatus*) swims in the shallows of Dimakya Island, Palawan, Philippines
(Photo: Steve De Neef, Greenpeace)

bays and gulfs that are critical marine habitats and destroying the spawning grounds of young fishes," *Ms. Ramos* stressed.

Oceana Philippines also noted that "only small, artisanal fisherfolk on less than 3 GT fishing vessels with passive fishing gears are allowed" to fish in municipal waters. These coastal territories are known as reproduction and spawning grounds for most fish species. Recent records show that the size of wild-caught fishes, like sardines, is shrinking, implying that they are being caught before they can grow big enough to properly reproduce. The VIIRS data from May 2020 detected these vessels within three major protected areas in El Nido-Taytay Managed Natural Resource and Protected Area, and Malampaya Sound Protected Landscape/Seascape, both in Palawan Province; and the Ticao-Burias Pass Protected Seascape, a marine corridor that covers the Provinces of Masbate, Camarines Sur, Albay, and Sorsogon.

Masbate Province, which has 20 coastal municipalities, had the highest number of detections in its municipal waters in May, at 320. Palawan registered 249, while Quezon Province, which faces the Pacific Ocean, had 208. These provinces are prolific sardine producers, together accounting for nearly 11,500 t in 2018, or 13 % of the country's total fisheries production, according to the Fisheries Statistics of the Philippines. *Ms. Ramos* attributed the increase in apparent illegal fishing during the lockdown period to the fact that "some enforcement agencies were diverted to other COVID-19-related tasks." As a result, illegal fishers took advantage of the lack of monitoring. However, some municipalities in the central Philippines joined forces to "enhance enforcement of fisheries and environmental laws in their municipal waters," she added.

It is unclear which of the numbers of detected vessels are local and those that are foreign since VIIRS only tracks strong luring lights, Oceana Philippines stated. But the figures underscore

the need for the Philippine Government to implement its vessel monitoring rules, which will require commercial fishers to install tracking devices "that will indicate the identity and specifications of the fishing vessel, aside from their real-time location." Commercial vessels fishing within municipal waters are a persistent problem in the Philippine fisheries sector, on which 1.9 million people depend for their livelihood, out of whom, around 1.0 million are community fishers from underprivileged communities.

Three-quarters of the country's waters are considered overfished, and wild-caught fish yields have decreased in recent years, prompting the Philippine Government to impose closed fishing seasons, strengthen the aquaculture sector, and speed up the declaration of marine protected areas. "We cannot allow illegal entry of commercial fishers in municipal waters," said *Hon. Gerard Montojo,* the Mayor of the island municipality of Romblon. "We need support in monitoring our municipal waters, and the tracking device installed on commercial fishing boats plying our territorial waters is a big help so we can run after them, seize their boats, and arrest them so they are held accountable by the law." But while legislation mandating the use of these tracking devices has been on the books since 2015, the implementation continues to be delayed, *Ms. Ramos* said. The commercial fishing sector is strongly opposed to the requirement, she said, "but this will not matter" if there is a political will to act.

Continued safeguarding of the environment

Communities in the biodiversity haven of Palawan Province in the Philippines earn millions in tourism-related services annually, but the industry has been paralyzed due to a lockdown aimed at suppressing the spread of COVID-19. The lockdown, which came into effect on 17 March 2020, has forced to close the tourist sites in the Province, affecting thousands of families dependent on tourism. Despite this, the communities continue to look after their protected areas, making sure that illegal logging and fishing activities do not proliferate during the lockdown period. Nonetheless, with proper handling of finances, the community organizations were able to sustain themselves and the areas they look after for a year, but interventions and support were necessary to keep these areas protected in the long run.

On a sweltering morning in April 2020, Park Manager, *Mr. Jose Mazo*, operates a motorized patrol boat that glides through the turquoise waters of Siete Pecados, a 52-ha marine protected area (MPA) off the town of Coron in northern Palawan. A world-famous tourist destination in the Philippines, Palawan receives more than a million tourists annually. The vibrant coral reefs, part of the country's total coral reef area spanning 26,000 km^2 of Siete Pecados welcomed 51,000 visitors in 2019 alone.

The months of March up to May are the busiest for Siete Pecados, and the daily monitoring routine was not new to *Mr. Mazo*, who has been at the MPA's helm for more than 15 years. Except that this time around, not a single tourist had come to snorkel in the park's municipal waters. Since 17 March 2020, Siete Pecados was temporarily closed to visitors after the national government imposed a lockdown to stem the surge of positive COVID-19 cases in the country.

The closure hurt the economy of the Province, which was largely dependent on tourism. In fact, tourism receipts amounted to PHP 83 billion (USD 1.6 billion) in 2018 alone. "Supposedly, now is the best time for us to earn more," *Mr. Mazo* said. "But we are forced to close the park, following the government's community quarantine directive." The site earned PHP 5.1 million (USD 100,000) from the entrance and environmental fees in 2019 but in 2020, they expected to lose PHP 1.5 million (USD 30,000) for March to May, *Mr. Mazo* declared. But beyond the earnings, the closure has also impacted the 92 members of their association and their families. "Each of them earns at least PHP 8,000–15,000 (USD 160–300) monthly for their outrigger boats that bring tourists to the marine park," *Mr. Mazo* said. "Now, that sure income is gone."

Thousands of families who depend on community-based sustainable tourism have been affected by the pandemic and lockdown policy in the Province of Palawan. In the provincial capital Puerto Princesa, some 420 km from Siete Pecados, 400 families work in the Puerto Princesa Subterranean River National Park (PPSRNP), a 22,202-ha UNESCO World Heritage Site renowned for its 8.2-km underground river, have lost their livelihood. During the prime tourist months, the site hits its daily maximum of 1,200 visitors. In 2019, it earned PHP 108 million (USD 2.1 million) in entrance fees from its 331,356 visitors. "For this peak season, our collective income loss was PHP 6 million or about USD 119,000," *Ms. Teresita Austria*, a representative of the Boat Owners' Association said.

During prime tourist months, the Puerto Princesa Underground River easily fills in its 1,200 daily carry-in capacity

(Photo: Haya Benitez)

Like in Siete Pecados' case, the boat operators for PPSRNP have suffered the most, as 314 of them have been left in limbo as their boats laid idle due to the lockdown. They used to earn PHP 10,000–15,000 (USD 200–300) monthly. While the government was expected to ease the lockdown by 1 May 2020, the halt to tourism activities will linger for the duration of the pandemic and cut off the main income source for thousands of tourism-dependent families here, *Mr. Mazo* said. Palawan is considered a low-risk area for COVID-19 infections, but as the pandemic paralyzes Palawan's tourism industry, resilient ecotourism communities embedded in biodiversity hotspots like Siete Pecados and PPSRNP have found sustainable ways to survive through the crisis, all the while not having to abandon their environmental conservation initiatives.

Monitoring work continues

One morning in April 2020, *Mr. Mazo* and his rangers checked the coral reefs for signs of bleaching and crown of thorns infestation in their MPA. Despite the drastic cut in daily income from tourism, the group continued to regularly patrol the park to ensure that it was free from illegal fishing activities. "Locals lost their tourism jobs due to the lockdown, and there is a possibility that some may turn to illegal fishing," exclaimed *Mr. Mazo*. Even the body that manages the MPA is not immune, as it had to let go of five of its 15 employees, retaining mostly rangers and garbage pickers.

In Siete Pecados, marine species such as the critically endangered hawksbill sea turtle (*Eretmochelys imbricata*) thrive alongside 74 species of reef fish, including the endangered humphead wrasse (*Cheilinus undulatus*). Other species of high conservation value previously seen here are the dugong (*Dugong dugon*), spotted eagle ray (*Aetobatus narinari*), and whale shark (*Rhincodon typus*). Before its designation as an MPA in 2005, Siete Pecados suffered from rampant illegal fishing activities, particularly the heavy use of cyanide, dynamite, and trawling from the 1980s to the late 1990s. This led to widespread coral reef destruction and fish stock depletion. But ecotourism and massive information campaigns halted this, according to *Mr. Mazo*. Coron, which is part of the Calamianes group of islands, is famous for its well-preserved underwater shipwrecks surrounded by coral reefs in good condition. "Since opening this area to tourists in 2004, those damaging activities were stopped and the impending fisheries collapse was averted," said *Mr. Mazo*, who has been at the forefront of mobilizing the community to combat illegal fishing in the area since the early 2000s. "The majority of fishers have migrated to tourism." It is the same in the PPSRNP, where boat operators, organized since 1991, were taking their part in safeguarding their seas. PPSRNP's 7,000-ha marine zone also suffered from the impact of illegal fishing in the 1990s, despite having been declared a protected area since 1971.

"Our task remains the same: report illegal fishers to enforcement authorities," *Ms. Austria* said. "Within our association, as most go back to their fishing job, we discourage them from using banned fishing methods." A model for balancing conservation and sustainable tourism, the national park is home to at least 1,024 terrestrial and marine wildlife species, some of which are endangered, rare, or endemic. But they are more at risk of vanishing if the plunder of habitats driven by food scarcity caused by the pandemic is left unchecked, says PPSRNP protected area superintendent *Ms. Elizabeth Maclang*. Park rangers continue to monitor the forested areas in the park during the lockdown, *Ms. Maclang* added. "The same monitoring is being done in marine zones because we have assumed that some may also engage in destructive fishing," she stated. "We are addressing the locals' needs by distributing relief goods and vegetable seedlings so they can plant and sell for their subsistence."

Back to basics

For the coastal ecotourism associations in Palawan, the COVID-19 pandemic has hit the reset button, pushing them to return to fishing and farming — their bread-and-butter livelihoods prior to the province's tourism boom. "It's kind of going back to basics," *Mr. Mazo*. Locals near Siete Pecados haul in an average daily fish catch of 10 kg each, almost triple the national average of 3.5 kg for small-scale fishers. *Mr. Mazo* attributed the robust fish catch to the declaration of the area as an MPA, which helped them ride through the lockdown. "Imagine if there are no tourism activities during the pandemic and the fish populations are depleted, we would not survive," he added.

"MPAs are there for the long gain," *Dr. Rene Abesamis*, a marine biology expert, declared. Well-managed MPAs serve as safe areas for fish where they spawn and grow and eventually move out, *Dr. Abesamis* said. Combined with sustainable fishing methods outside the MPA, fish biomass improves and marine food security stabilizes. "The biomass that took many years to accrue" inside MPAs, *Dr. Abesamis* warns, can be

Underwater image of Siete Pecados, one of the most well-managed marine protected areas in the Philippines

(Photo: Gerald R. Mondala)

substantially reduced by illegal fishing and poaching activities. That is why "it is really important to continue protecting the protected areas even in trying circumstances like the current pandemic," he said. "If the communities stop being vigilant, the effect will be very big in the long run."

Decades of conserving PPSRNP's vast marine zone have also paid off, yielding bountiful fish harvests for locals in these trying times. "Fishing boats here are brimming that you can buy high-valued fish species like *lapu-lapu* (groupers) for as low as PHP 100 (USD 2) per kilogram," *Ms. Austria* said, adding that they have asked commercial markets in the city to buy their catch so it would not be spoiled and members will have an alternative cash source. *Ms. Austria* has also rekindled her subsistence organic farm during the lockdown, planting fast-growing vegetables in her 1-ha property located at the foot of the Park's iconic Karst mountains. "The adjustment is difficult because we were now used to earning more from tourism than farming and fishing combined," she added.

Tourism's "easy money" drove numerous locals away from farming and fishing, Austria exclaimed. "The pandemic has forced many to realize how equally important those forgotten and underappreciated sectors are, especially now that the tourism industry has slumped." Community-based tourism has improved the once economically deprived villages in the province, but many believe that regaining the economic momentum remains a challenge in the age of COVID-19. Locals, nonetheless, were hoping against hope that the tourism industry will rebound soon, or at least in time for the next peak season, which begins in the fourth quarter of 2020. If not, they look forward to the same period next year. "Once the situation improves, we expect tourism here to bounce back by 2021," *Mr. Mazo* said.

While the restrictions continue, *Mr. Mazo* indicated that the management of Siete Pecados has PHP 2 million (USD 40,000) in reserves to support its 10 employees until next year, and another PHP 4 million (USD 80,000) for coastal resources management. But despite this, the situation remained uncertain. The provincial tourism office was preparing a recovery plan to help tourism-dependent workers, but no concrete details have been released as of the time being. "Whether tourists would come back after the Philippine lockdown is lifted, is our concern," *Mr. Mazo* said, adding that the majority of the site's foreign visitors came from European countries like Spain and France which are still grappling with the pandemic.

Meanwhile, *Ms. Austria* was pinning her hopes on the discovery of a vaccine for the virus. The Palawan Provincial Office had earlier said that without a vaccine, inbound and outbound travel is banned in the Province. "If we find a cure to coronavirus," *Ms. Austria* said, "then there is a fighting chance we can revive the dying tourism industry that gives life to everyone here."

COVID-19 hits seafood sales

Meanwhile, in Indonesia, measures have also been taken to prop up the declining sales of fish amid a slump in demand caused by the people's response to the COVID-19 pandemic. Restaurants and shopping malls have been shut down in most large cities across the country as part of social distancing measures, leading to the decline in demand for seafood. Fish exports have also slowed as Indonesia, like many other countries, has restricted its trade with other affected countries.

At a fishing port in Lamongan, Eastern Java, Indonesia, a fisher *Mr. Muhammad Fauzi* while unloading his catch after spending days out at sea, stated that he still goes fishing even though sales have dropped in the past couple of months due to the novel coronavirus outbreak. "If I do not go, what work will I do? If had a farm, I would rather do that," *Mr. Fauzi* said in an interview at the port in Lamongan. *Mr. Fauzi* is one of hundreds of thousands of Indonesians whose livelihood depends on fishing. But a string of measures by authorities to curb the spread of COVID-19 has been a blow to many local industries, including fisheries.

In the case of *Mr. Fauzi*, he said he used to earn up to IDR 5 million (USD 300) for 15 days of fishing. Recently, however, he has been making IDR 1.5 million (USD 90) at most, while his expenses remain the same. "So working at sea is almost a waste," *Mr. Fauzi* declared. Meanwhile, *Ms. Siti Aminah* works at the Lamongan Fish Port sorting the catch that the fishers bring in. She said she hoped the virus would not hit the area, otherwise, authorities would be forced to shut down the port, leaving her out of a job. The ongoing drop in sales has already slashed her daily income by half, she said. "Before the virus outbreak, many tourists came here."

But as long as no outsiders enter anymore, it should be safe," *Ms. Siti* said. In the wake of the outbreak, now a global pandemic, Indonesia has followed the steps of other countries around the world to impose travel and trade restrictions in an effort to slow the spread of the virus. Fish exports to China, in particular, have declined significantly. The move has hit the shrimp-fishing community in Sumatra's Jambi Province, Indonesia which is highly reliant on the Chinese market (Mubarok & Ambari, 2020). Since Indonesia reported its first confirmed COVID-19 infections on 2 March 2020, local governments have restricted travel between provinces and cities. Food shipments were exempted from these restrictions, but demand has gone down with the temporary closure of restaurants and shopping malls.

That has had an impact on fishers in East Java and across the country, said *Mr. Ibrahim*, Head of the Lamongan Port Authority. He said much of the fish being brought in was now piling up in cold storage. Fish exports from the port have dropped by as much as 70 % since February 2020, *Mr. Ibrahim* added. Destination countries include France,

Fishers' catches are piling up in cold storage as demand for seafood slumps amid restaurant closures

(Photo: Falahi Mubarok, Mongabay Indonesia)

Italy, Netherlands, the U.S., Thailand, Taiwan, and China. Fishers from the north coast of Java, an area known as Pantura, have raised concerns about the impact on their industry and communities. Nonetheless, the Ministry of Marine Affairs and Fisheries (MMAF) has indicated it will make efforts to prop up fish sales and provide fishers with financial aid in the meantime. Among the measures, it was required that cold storage companies take in all the fish brought to port. It was also overseeing the supply of fish pellets and other aquaculture items to fish farmers. "The Indonesian President's message is very clear that amidst the COVID-19 pandemic, the government must sustain productivity, purchasing power, and food supply," said *Mr. Slamet Soebjakto*, Director of Aquaculture at the MMAF. "Stakeholders need not worry as the MMAF continues to monitor every event in the field and is prepared to be involved at any time," he exclaimed.

COVID-19 no excuse for dropping guard against illegal fishing

The Indonesian authorities also indicated that they would remain vigilant for illegal fishing practices as poachers and blast fishers anticipate a dip in enforcement activity amid COVID-19 restrictions. Since 1 March 2020, Indonesian authorities have seized 19 foreign fishing vessels which were not allowed to operate in Indonesian waters, and have also reported a growing number of cases of blast fishing. The MMAF would not drop its guard but had seen its budget for 2020 slashed by more than a quarter as the government reallocated funding for the COVID-19 response. Among the affected programs was the stimulus initiative package to prop up fish sales and provide fishers with financial aid as the health crisis hits seafood sales and demand.

Fishers were taking advantage of a perceived drop in enforcement amid the COVID-19 crisis to operate illegally in Indonesian waters, Indonesian officials stated. Indonesia has since November 2014 banned foreign fishing vessels from operating in its waters, home to some of the world's richest fish stocks. Indonesian fisheries law also bans destructive fishing methods, including the use of explosives and cyanide. But travel bans and other restrictions imposed in response to the COVID-19 pandemic appeared to have encouraged some fishers to try their luck. "In conditions like these, destructive fishing practices are potentially increasing, and this must remain a concern for all authorities and regional governments," *Mr. Haeru Rahayu*, Director-General of Marine and Fisheries Resources of the MMAF said.

Authorities have seized at least 19 foreign fishing vessels since 1 March 2020, a day before the country reported its first confirmed COVID-19 case. These vessels bore the flags of Viet Nam, Malaysia, and the Philippines, and were caught in separate incidents off North Natuna, in the Sulawesi Sea, and the Malacca Strait. At the same time, the government has also reported a growing number of cases of destructive fishing by local fishers across the archipelago. *Mr. Haeru* said his team had anticipated the "uptick in illegal fishing by foreign vessels" trying to operate under the impression that the COVID-19 measures would result in less maritime vigilance by Indonesian authorities.

"Amid the COVID-19 pandemic, the MMAF was absolutely not relaxing its operations to protect the sovereignty of fisheries management in the Republic of Indonesia," *Mr. Haeru* said. "Our monitoring fleets are staying ready in sites that are prone to illegal fishing."

An Indonesian maritime patrol monitors for signs of illegal fishing *(left)* and a foreign fishing vessel seized for fishing illegally in Indonesian waters *(right)* *(Photo: MMAF Indonesia)*

Indonesia's former Minister for the MMAF, *Ms. Susi Pudjiastuti*, who enacted the ban on foreign fishing, gained widespread popularity for a policy of seizing these vessels and later sinking them to create a deterrent effect and prevent their possible reuse for illegal fishing (Kaye, 2015). The policy, though controversial with some of the flag countries of the capsized vessels, was praised by experts and the public at home and abroad, and was considered to have helped replenish fish stocks in Indonesian waters. But law enforcement at sea remains a key challenge for the Southeast Asian nation, whose more than 17,000 islands and the third-longest coastline in the world made it difficult to detect illegal and destructive fishers seizing on blind spots in monitoring. The incumbent Minister for MMAF, *Mr. Edhy Prabowo*, has also been criticized by experts for considering a plan to end the sinking of seized illegal boats (Ambari, 2019).

Marine observers have called on the government to beef up efforts to guard the country's waters and fishery resources from illegal and destructive practices amid the coronavirus crisis. "Generally, an economic crime which is an organized action always looks for that moment when monitoring by state authorities is weak or absent," *Mr. Mas Achmad Santosa*, former coordinator of Indonesia's anti-illegal fishing task force and current Executive Director of the think tank Indonesia Ocean Justice Initiative, declared. *Mr. Santosa* urged the MMAF to maintain or, if possible, increase monitoring days by the coast guard from the current 150 days per year, and optimize the use of satellite tracking systems for vessel monitoring, such as automatic identification system (AIS) and vessel monitoring system (VMS). "It is very possible that the budget for maritime monitoring is reduced because the priority is now focused on combating COVID-19," *Mr. Santosa* said. "But I appreciate the MMAF which has seized 19 foreign boats amid the COVID-19 pandemic. It shows that monitoring is not relaxed."

The MMAF reported on 22 April 2020 that its budget for this year has been slashed by IDR 1.8 trillion (USD 119 million), or more than a quarter, to provide funding for tackling the COVID-19 outbreak in the country. Among the affected programs was a stimulus package to prop up fish sales and provide fishers with financial aid as the health crisis hits seafood sales and demand, and the stimulus has been cut by 17 % or IDR 362 billion (USD 24 million). Activists said that the government should prioritize the social safety net for the 8 million households who depend on fishing for a livelihood (Gokkon *et al*., 2019).

These activists have called for, among other things, funds to be reallocated from the IDR 9.93 trillion (USD 657 million) budget for the 2020 local elections. "The government must allocate special funds for fishing households whose incomes have dropped due to the COVID-19 outbreak," said *Ms. Susan Herawati*, the Secretary General of the People's Coalition for Fisheries Justice (KIARA), a local NGO.

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About the Authors

Ms. Leilani Chavez is a Tokyo-based freelance journalist with more than a decade of experience covering the intersections of politics and the environment in the Philippines. She has written features and investigative stories for the Philippine Center for Investigative Journalism (PCIJ), ABS-CBN News Online, Rappler, Newsbreak, and other local and international news outlets.

Mr. Keith Anthony Fabro is a Philippine-based freelance environmental journalist who covers endangered species, habitat degradation, climate crisis, and sustainable development. His articles have appeared in Rappler, Mongabay, China Dialogue, and other news outlets.

Mr. Falahi Mubarok is an Indonesian journalist working for Mongabay.com

Mr. M Ambari is an Indonesian journalist working for Mongabay.com

Mr. Basten Gokkon is a writer, reporter, and author of news articles and features for Mongabay.com, U.S.-based non-profit conservation, and environmental science news platform. Mongabay.com publishes news on environmental science, energy, and green design, and features extensive information on tropical rainforests, including pictures and deforestation statistics for countries around the world. Mongabay.com is the primary distribution platform for content produced under Mongabay.org.

Safer Now at Sea: developing a lower-cost system for tracking small-scale fishing vessels in the southern Philippines

Laura Villadiego

Nowadays, consumers are demanding to know where the seafood they buy comes from to ensure catches are legal, sustainable, and free from labor abuse. The technology to deliver that information, once out of reach for small-scale fishers, is becoming more accessible in places like the Philippines. Its adoption is not only increasing seafood traceability but also improving the safety of fishers while they are out on the water. Small-scale fishers and their families, among the most vulnerable in the seafood supply chain, have welcome the security and peace of mind the technology brings.

In General Santos in the southern Philippines, known as the tuna capital of the Philippines, wives of tuna fishers like *Ms. Maylene Bibat* are thrilled every time she sees the green dot on her tablet marking the location of her husband's fishing boat. "I instantly felt less worried as it is like knowing that he was safe," *Ms. Bibat* said. For years, *Ms. Bibat* had to wait anxiously in silence in her small village in the southern Philippines while her husband, *Mr. Harry Bibat*, was at sea catching the tuna the family depends on. Hundreds of miles offshore, there was no way for him to communicate with her, often for days at a stretch. But no longer now.

With fish stocks depleted due to overfishing and after a number of scandals around the use of forced labor on fishing vessels, consumers and companies are increasingly demanding to know the origin of the fish they buy. For instance, in 2017 some of the biggest industry players in the sector launched the Global Tuna Alliance to deter illegally caught tuna from getting to market and to promote "improvements in the environmental sustainability and human rights in tuna fisheries." Not only big fishing vessels but also smaller boats are now installing systems to track where they catch fish and register the data for others in the supply chain to see. These systems are changing the lives of small-scale fishers like *Mr. Bibat* in an unexpected way, as this has enabled them to stay in touch with their families. "Now the life of a fisherman is more challenging than it used to be when I was helping my father [as a kid]," said *Mr. Bibat*, who owns a handline boat that only fits two people.

Last year, *Mr. Bibat* made room in his boat for a small transponder that registers the position of the craft and sends it through radio frequencies to the cloud. He placed it on top of one of his two masts. Data from the transponder is available to

Fishers prepare nets at port in General Santos, Philippines
(Photo: Biel Calderon)

seafood companies, as well as on *Ms. Bibat*'s tablet through an application that displays the location and speed of his boat. "It is a big help for my family to be able to monitor my location while I'm fishing," *Mr. Bibat* said. The emotional relief is more needed today than ever, as *Mr. Bibat*'s trips have become increasingly risky as he has to spend longer at sea because the fish around General Santos, the so-called tuna capital of the Philippines just a few miles west of *Mr. Bibat*'s village, have vanished. Nonetheless, this new lower-cost system for tracking vessels and fish catches is also improving safety and communications for small-scale fishers and their families.

Fewer fish means farther fishing

Seafood traceability initially emerged as a food safety tool to enable product recalls. However, the overexploitation of fish stocks led governments and industry players to seek better control of what was caught and where. Over the past two decades, tracking and monitoring systems have been deployed on fishing vessels to deter the illegal harvesting of seafood.

Marine fishery resources have been on a continuous decline since the 1970s, according to the Food and Agriculture Organization of the United Nations (FAO). Back then, 90 percent of fish stocks were fished within biologically sustainable levels, but that percentage slipped to just under 70 percent in 2015 (FAO, 2018). The situation is even worse for tuna as only 57 percent of stocks of the seven main targeted species were fished within biologically sustainable levels in 2015. In the Asia-Pacific region, scientists with the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) warned that exploitable fish stocks will be gone by 2048 "if current fishing practices continue."

One particular controversial practice is the use of fish aggregating devices or FADs, artificial shelters that attract fish and make it possible to catch large quantities easily. FADs are seen as a major contributor to declining global tuna stocks. "Before there was always a good catch, always plenty of tuna nearby but when these FADs were introduced and there was an over-deployment of FADs, these municipal fishers had to go further away," said *Mr. Raul Gonzalez*, Spokesperson for the Alliance of Tuna Handliners in General Santos. "This [fish decline] entails costs and also longer periods of fishing and also the dangers that are inherent in this kind of fishing operation." However, tuna populations in the area have improved slightly over the past five years after neighboring Indonesia reined in the use of FADs in its waters, *Mr. Gonzalez* said.

Nevertheless, *Mr. Bibat* has not noticed a big increase in the tuna populations yet and is traveling farther out to sea than ever to pursue them. But he does feel safer at sea, thanks to the transponder. His wife *Ms. Bibat* sends him information about weather conditions and gives him advice on where to fish or when it would be advisable to return to port through the application. The transponder also allows *Mr. Bibat* to check his wife's messages with his mobile phone and answer them through chat and SMS services. "Once I got lost because of heavy wind and huge waves, now this would not happen again if I have a transponder because there is a system that can send information if there is a force majeure and makes me aware and prepared," he said. "I feel safe and confident during the fishing trips."

Another tuna fisher, *Mr. Roger Tuasic* has a different hope for the new transponder on his boat, that it will keep him and his son out of jail. The scarcity of fish has also pushed *Mr. Tuasic* to venture farther out to sea and, sometimes, to cross the maritime border with Indonesia. *Mr. Tuasic* was caught seven times in the past while working on a big fishing vessel but always quickly released, but now Indonesian authorities have become stricter. They jailed his son for two-and-a-half years the last time he was arrested, *Mr. Tuasic* said. "This is why I decided to use small fishing boats and fish locally, even though it does not provide sufficiently for my family," he said. But the risk remains because fishers in small boats can also cross the border accidentally without devices to determine their exact location. "We can also see … how much fish they have caught and if it is big or small tuna" before the boat reaches the shore, said his wife, *Ms. Adelaida Tuasic*.

Out of reach of small-scale fishers

After years of working in a canning plant seven days a week for a meager salary, *Mr. Jason Albasi* thought the way to make ends meet was to buy a tuna handliner. He had learned the job from his father and heard that a single big tuna could sell for as much as PHP 60,000 (around USD 1,200) at the port in General Santos — five times his monthly salary at the canning plant.

Workers carry a yellowfin tuna (*Thunnus albacares*) at the port in General Santos
(Photo: Biel Calderon)

But it didn't turn out to be that easy. With the decline of tuna stocks, fishing also became more expensive. "One-third of the income goes to cover the trip expenses, such as fuel or ice to preserve the tuna," *Mr. Albasi* said. Once ashore he also has to pay the crew. In the end, there's little left in his pocket.

The traceability requirements only increased the burden. In 2014, the Government of the Philippines began requiring fishing vessels to carry a vessel monitoring mechanism (VMM), a device that records their movements to discourage or penalize illegal fishing. The requirement did not yet apply to small-scale fishing vessels less than 30GT but it likely will in coming years.

Some markets, like the tuna industry, are also increasingly demanding that each fish comes with data on where and when it was caught, mostly through electronic catch documentation and traceability (eCDT) technologies that send the information to the cloud so buyers can access it. "Right now, it is not required by law but I know they will ask us soon," said *Mr. Albasi*.

VMM and eCDT systems can cost hundreds of dollars a month in subscription charges — unaffordable for small-scale fishers like *Mr. Albasi* or *Mr. Bibat*. The traceability systems also often entail complicated bureaucratic tasks that fishers, who are sometimes illiterate, can find difficult to complete. Yet small-scale fisheries account for more than 90 percent of the world's fishing workforce and produce around half of the global catches, according to FAO. So, bringing them on board is essential for traceability initiatives to work.

Engr. Arcelio Fetizanan, Jr. identified that gap and figured out how to simplify the complex tracking systems used by aircraft and large fishing vessels so small-scale fishers could also benefit from them. "What we are doing is to actually make it easier also for the [small-scale] fishers to comply with the regulations," *Engr. Fetizanan* said.

With his Manila-based technology provider company, Futuristic Aviation and Maritime Enterprise (FAME), *Engr. Fetizanan* developed a transponder that uses radio frequency cards that automatically register location and time data for each catch and create an ID for each fish. "We put [a card] on the tuna, normally on the fin, so we can actually monitor and trace where it was caught and how it was caught," *Engr. Fetizanan* said. Technicians at FAME work on a transponder that is helping small-scale fishers in the Philippines comply with the country's new vessel-tracking regulations as well as stay in touch with their families while they're at sea.

The technology not only enables fishers to easily comply with vessel tracking regulations, but also simplifies the paper-based catch documentation systems that most small-scale fishers still use in the Philippines. "They don't need to write something on paper or on mobile, just with tapping [the card against the transponder] they are already complying with the regulations," *Engr. Fetizanan* said.

FAME has also reduced the cost of the subscription to PHP 800 a month (around USD 185 a year). Even so, without being sure they could get a premium price for their fish if they used the technology, local fishers deemed the investment too risky. They could only afford it with a special subsidy from the USAID Oceans and Fisheries Partnership, which so far has covered one year's subscription fees for 26 fishers in General Santos, including *Mr. Bibat*, *Mr. Tuasic*, and *Mr. Albasi*. It has also equipped local governments with small offices for tracking vessel locations and data.

"Seafood is no longer an unlimited, promised resource. Without action against IUU [illegal, unreported, unregulated] fishing, U.S. consumers' continued access to the proteins they rely on is not guaranteed," said the acting director of USAID's regional development mission for Asia, *Mr. Jeffrey Spence*, in an email, by way of explaining the interest of the U.S. in encouraging the use of this technology. The U.S. is the world's second-largest seafood importer and imports more than 90 percent of the seafood consumed there.

To *Mr. Bibat*'s relief, the FAME transponder on his boat is also equipped with an emergency button that he and his crew can press if they find themselves in trouble. "When they click, it automatically sends different signals to the cloud giving them the assurance that someone knows that they have a problem," *Engr. Fetizanan* said. That button is one of *Ms. Bibat*'s favorite features. "If Harry presses it, we can call the coast guard to go rescue them. In addition, since the boat is being tracked, it is easy to find them. Before it could take days," she said. In spite of all the fancy devices *Ms. Bibat* and *Mr. Bibat* now use, the entrance of their house is still well guarded by an elaborate Catholic altar presided over by an image of the Virgin Mary. "The device might help," *Ms. Bibat* said, "but God sees everything."

Reference

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About the Author

Laura Villadiego is a freelance journalist specializing in human rights, labor issues, and the environment. Based in Thailand, she has been covering Southeast Asia and authored reports and articles for Mongabay.org. Her article originally appeared at https://news.mongabay.com/2019/11/safer-at-sea-the-unexpected-benefit-of-traceability-for-small-scale-fishers/.

Guide to Contributing Articles

Fish for the People is a policy-oriented Special Publication produced by the Southeast Asian Fisheries Development Center (SEAFDEC). The first issue of the Special Publication was launched in early 2003 to commemorate the first anniversary of the ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security in the New Millennium: "Fish for the People" organized in 2001 from which the Special Publication got its banner title *Fish for the People*. Through the years, *Fish for the People* has been recognized by various stakeholders as a significant source of information to support their works on the sustainable development and management of fisheries and aquaculture in the region. The SEAFDEC Secretariat publishes three issues of the Special Publication each year with support from the Japanese Trust Fund. The publication of articles in *Fish for the People* is free of charge.

Prospective Contributors

- **SEAFDEC Secretariat and Departments** (researchers, technical staff, project managers)
- **SEAFDEC Member Countries** (national focal persons of SEAFDEC projects, researchers, fishery officers, professors, students)
- **SEAFDEC partner organizations** (researchers, technical staff, project managers)
- **Non-member countries and other organizations** (researchers, project managers of projects in the SEAFDEC Member Countries, researchers, fishery officers, professors, students, and those who wish to share experiences that could be applicable to Southeast Asia)

Themes and Topics

- Achievements of SEAFDEC projects and activities in Member Countries
- Recent developments in fisheries and aquaculture of Southeast Asia
- Advancements in fisheries and aquaculture from other countries relevant to Southeast Asia

Structure and Format

- Please see the structure and format of published articles of *Fish for the People* before writing your article
- Articles should be written in popular language for easy reading by relevant stakeholders
- Articles should contain standard style and formats, proper citations, and gender-sensitive and inclusive language based on SEAFDEC Style (http://www.seafdec.org/documents/2021/12/seafdec-style.pdf)
- Articles should be written in correct English before submission by using the spell-check and grammar-check functions and applications to avoid unnecessary errors
- An article should be written in a maximum of 10 pages (including tables and figures, Times New Roman font 11, single space, one-column layout)
- Tables should be created as editable text, not as images
- Figures should be in line with text, not wrapped with text; figure caption should be written below the figure, not in a text box
- Articles should be free of plagiarism and false information; SEAFDEC will not be responsible for any copyright violations
- Articles should contain the essential elements, as appropriate (Title, Abstract, Keywords, Introduction, Materials and Method, Results and Discussion, Way Forward, Funding Source, References, and Name and Affiliation of Authors)

Publication Process

Step 1. Submission

- Please submit the editable file of the article to the Editor of *Fish for the People* through the SEAFDEC Secretariat at fish@seafdec.org

Step 2. Evaluation

- Articles from SEAFDEC will undergo the review and approval mechanism within the respective Departments
- Non-SEAFDEC articles will be evaluated by the Editorial Team; highly technical articles will be reviewed by specific experts from the SEAFDEC Departments and/or external reviewers, as necessary

Step 3. Revision

- The Editor will communicate with the corresponding author for the editing and revision of the article

Step 4. Publication and promotion

- Approved articles will be published in electronic and printed formats
- Published articles in electronic format will be immediately and permanently made accessible for free read and download from the SEAFDEC Institutional Repository; a unique link will be assigned to each published article which can be shared through any communication channels including email and social media
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CALENDAR OF EVENTS

Date	Mode/Venue	Event	Organizer
		2022	
21–22 February	Online workshop	2nd Regional Workshop on the Study on Impacts of COVID-19 Pandemic on the Fisheries Sector of the ASEAN SEAFDEC Member Countries	SEAFDEC Secretariat
21–24 February	Online training	Training on Gender Awareness and Gender Mainstreaming in Fisheries in Indonesia	SEAFDEC/TD
16-17 March	Online meeting	5th Meeting of the Regional Scientific and Technical Committee for SEAFDEC/UNEP/GEF Fisheries *Refugia* Project	SEAFDEC/TD/ *Refugia* Project
23-24 March	Bangkok, Thailand (and online)	RES&POA-2030: Regional Workshop on Development of the Key Indicators and Detailed Roadmap	SEAFDEC Secretariat
20 April	Bangkok, Thailand (and online)	Regional Workshop for the Finalization of the Study Report on Impacts of COVID-19 Pandemic on the Fisheries Sector of the ASEAN-SEAFDEC Member Countries	SEAFDEC Secretariat
13 May	Online talk	FAO in Geneva Agriculture Trade Talks: Illegal, Unreported, and Unregulated (IUU) Fishing	FAO
23 and 25 May	Online meeting	54th Meeting of SEAFDEC Council	DOF Malaysia and SEAFDEC Secretariat
24-27 May	Virtual meeting	11th Session of the FAO Sub-Committee on Aquaculture	FAO/HQ
25 May	Bangkok, Thailand (and online)	Training Course Program on Inland Fisheries EAFM for the Department of Fisheries, Thailand	SEAFDEC/TD
26–27 May	Online training	Online Training on Preparation and Installation of the eACDS Application to Server for Brunei Darussalam	SEAFDEC/TD
27 May	Bangkok, Thailand (and Online)	7th Meeting of the Project Steering Committee for SEAFDEC/UNEP/GEF Fisheries *Refugia* Project	SEAFDEC/TD/ *Refugia* Project
30 May–3 June	Rome, Italy	Technical Consultation on Voluntary Guidelines for Transshipment	FAO/HQ
30 May	Online workshop	Regional Workshop on Gender Dimension in the Value Chain of Small-scale Fisheries and Aquaculture in Southeast Asia	SEAFDEC/TD
1–3 June	Samut Prakan, Thailand	2nd Writeshop on Developing Training Modules of Gender Mainstreaming in Small-scale Fisheries	SEAFDEC/TD
6 June	Online talk	Online Talk: Closing the Net on IUU Fishing	FAO
7-9 June	Online workshop	Workshop on Advancing Regional Standards of Responsible Fisheries to Combat IUU Fishing	RPOA-IUU
7-9, 20 June	Virtual meeting	18th Session of FAO Sub-Committee on Fish Trade	FAO/HQ
8 June	Online event	United Nations World Oceans Day Event	UN
14–15 June	Online workshop	RES&POA-2030: Regional Workshop for Finalization of the Indicators	SEAFDEC Secretariat
20–24 June	Virtual meeting	27th Session of the Coordinating Working Party on Fishery Statistics (CWP)	FAO
21 June	Virtual meeting	14th Meeting of the ASEAN Fisheries Consultative Forum (AFCF)	ASEAN
21–23 June	Online training	Online Training Course on Energy Audits for Fishing Vessels	SEAFDEC/TD
22-23 June	Virtual meeting	30th Meeting of the ASEAN Working Group on Fisheries (ASWGFi)	ASEAN
27-29 June	Chonburi Province, Thailand	Regional Workshop on Finalizing the Training Modules on Gender Mainstreaming in Small-scale Fisheries	SEAFDEC/TD
28–30 June	Online training	Online Regional Training Course on Fish Handling Onboard Fishing Vessels	SEAFDEC/TD
8 July	Pattani Province, Thailand	Onsite Training Program on Fish Handling Onboard Fishing Vessels	SEAFDEC/TD
11-15 July	Seoul, Republic of Korea (and online)	Regional Coordination Meeting on the FAO Agreement on Port State Measures: Asia	FAO
26–27 July	Online workshop	Workshop on Fisheries Data Collection and Statistics (Asia and Pacific)	FAO
23–26 August	Bangkok, Thailand	2nd Regional Technical Consultation on Fishery Statistics and Information in Southeast Asia	SEAFDEC Secretariat
29 Aug–6 Sep	Samut Prakan, Thailand (and online)	2nd Regional Training Workshop on Stock Assessment in Support the Implementation of the International Commitments for Sustainable Use of Fisheries Resources	SEAFDEC Secretariat
30 Aug–1 Sep	Bangkok, Thailand	Regional Technical Consultation on Development of the ASEAN-SEAFDEC Common Position on the Proposed Listing of Commercially-exploited Aquatic Species into the CITES Appendices	SEAFDEC Secretariat

Southeast Asian Fisheries Development Center (SEAFDEC)

What is SEAFDEC?

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

Vision

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

Mission

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

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


Secretariat

TD

MFRD


AQD


MFRDMD


IFRDMD

SEAFDEC Addresses

Secretariat

P.O. Box 1046
Kasetsart Post Office
Bangkok 10903
Thailand
Tel: (66-2) 940-6326
Fax: (66-2) 940-6336
E-mail: *secretariat@seafdec.org*
http://www.seafdec.org

Training Department (TD)

P.O. Box 97
Phrasamutchedi
Samut Prakan 10290
Thailand
Tel: (66-2) 425-6100
Fax: (66-2) 425-6110 to 11
E-mail: *td@seafdec.org*
http://www.seafdec.or.th

Marine Fisheries Research Department (MFRD)

52, Jurong Gateway Road,
#14-01, Singapore 608550
Tel: (65) 9046-4787
Fax: (65) 6334-1831
E-mail: *Ong_Yihang@sfa.gov.sg*
http://www.seafdec.org

Aquaculture Department (AQD)

Main Office:
5021 Tigbauan, Iloilo, Philippines
Tel: +63 33 330 7000
Fax: +63 33 330 7002
Manila Office:
Room 100-E, Ground Floor
Philippine Social Science Center (PSSC)
Commonwealth Avenue, Diliman
1101 Quezon City, Philippines
Tel & Fax: +63 2 8927 7825
E-mail: *aqdchief@seafdec.org.ph*
http://www.seafdec.org.ph

Marine Fishery Resources Development and Management Department (MFRDMD)

Taman Perikanan Chendering,
21080 Kuala Terengganu, Malaysia
Tel: (609) 617-5940
Fax: (609) 617-5136
E-mail: *mfrdmd@seafdec.org.my*
http://www.seafdec.org.my

Inland Fishery Resources Development and Management Department (IFRDMD)

Jl. Gub. HA. Bastari No.08
RT.29 RW.27 Kel. Silaberanti
Kec. Seberang Ulu I, Jakabaring, Palembang 30252
Sumatera Selatan, Indonesia
Tel: +627115649600; Fax: +627115649601
E-mail: *ifrdmd@seafdec.id*
http://www.seafdec.id

The third prize winner, *Maneerat Charoenphon*, from the national drawing contest in Thailand

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