SEAFDEC Annual Report 2020

Southeast Asian Fisheries Development Center

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Preparation and Distribution of this Document

This SEAFDEC Annual Report 2020 was prepared by the Secretariat of the Southeast Asian Fisheries Development Center (SEAFDEC) in collaboration with the SEAFDEC Departments, namely: Training Department (TD), Marine Fisheries Research Department (MFRD), Aquaculture Department (AQD), Marine Fishery Resources Development and Management Department (MFRDMD), and Inland Fishery Resources Development and Management Department (IFRDMD). The Annual Report is distributed to the SEAFDEC Member Countries and Departments, collaborating agencies and other fisheries-related organizations, and to the public to make them aware of the activities and achievements of SEAFDEC and to promote its visibility.

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EXECUTIVE SUMMARY

The progress and achievements of SEAFDEC through the programs and activities undertaken in 2020 have been summarized in this SEAFDEC Annual Report 2020, for the awareness of concerned stakeholders. The programs implemented by SEAFDEC are in line with the priority needs and policy directives of the Member Countries that had been conveyed through the SEAFDEC Council and the SEAFDEC Program Committee, and are categorized into: 1) Projects under the Fisheries Consultative Group of the ASEAN–SEAFDEC Strategic Partnership (FCG/ASSP) Mechanism (16 projects); Departmental Programs (10 programs); and Other Programs (3 programs). Moreover, these programs have also been aligned with the *"SEAFDEC Strategies Towards 2030"* adopted by the SEAFDEC Council in 2017, comprising six Strategies, namely: 1) Securing the sustainability of fisheries to contribute to food security, poverty alleviation and livelihood of people in the region; 2) Supporting the sustainable growth of aquaculture to complement fisheries and contribute to food security, poverty alleviation and livelihood of people in the region; 3) Ensuring the food safety and quality of fish and fishery products for the Southeast Asian region; 4) Enhancing trade and compliance of the region's fish and fishery products with market requirements; 5) Addressing cross-cutting issues, such as labor, gender and climate change, related to international fisheries; and 6) Empowering SEAFDEC to strengthen its roles in the region and to improve its services for the Member Countries.

While sustaining the implementation in 2020 of the approved programs, SEAFDEC also continued to strengthen its cooperation and partnership with other international and regional organizations, national agencies of the Member Countries, as well as non-member governments that share common interests toward sustainable development of fisheries. More specifically, in terms of availing of their expertise and relevant resources for the programs and activities that are of mutual interest.

Despite the onslaught of the coronavirus (COVID-19) in 2020 leading to a worldwide pandemic, SEAFDEC continued to carry out the activities as planned, but mostly through virtual means with a view to ensuring that such programs could continue to address the common concerns of the Member Countries. Moreover, efforts have been sustained by the SEAFDEC Departments to implement the Information Strategies, especially the compilation of outputs from programs and projects, and dissemination of the results and outputs to target audience. Furthermore, the progress in the implementation of the Gender Strategy by the SEAFDEC Departments has also been monitored and summarized in this Annual Report, considering that the SEAFDEC Gender Strategy was adopted by the SEAFDEC Council in 2019.

This SEAFDEC Annual Report 2020 therefore contains the compilation of the progress and developments related to the implementation of the SEAFDEC programs and activities in 2020. SEAFDEC hopes that the Annual Report would serve as a reference for the SEAFDEC Member Countries, partners, and the public in obtaining a better view of the roles, activities and achievements of SEAFDEC while supporting the Member Countries in their respective efforts towards achieving sustainable development of fisheries.

MESSAGE FROM THE CHAIRPERSON OF SEAFDEC COUNCIL

The year 2020 had been one of the most challenging years for SEAFDEC and for the fisheries sector not only in the Southeast Asian region but also throughout the world. Such difficult situation had been brought about by the coronavirus (COVID-19) pandemic towards the end of 2019 and continued throughout 2020 necessitating the adoption of measures on controlled movement of people to avoid the widespread of the virus. These measures however, had created drastic consequences and impacts on the demand as well as the supply chain of fish and fishery products worldwide. This pressing situation has added-up to the existing challenges faced by the Southeast Asian countries, including the need to sustain continued efforts for combating IUU fishing, enhancing the sustainable production and contribution of capture fisheries and aquaculture to food security and livelihood of people, improving safety and quality of fish and fishery products, as well as boosting the competitiveness of fish and fishery products in the international market.

Despite the COVID-19 pandemic in 2020 and in the midst of those challenges, SEAFDEC still continued to implement its activities in support of the Member Countries, particularly the ASEAN Member States. As a matter of fact, such a situation opened up new opportunities of implementing the SEAFDEC activities through online mode. We could see the number of meetings, training courses and workshops, which SEAFDEC organized through online platforms, although the conduct of some activities planned to be carried out onsite in foreign countries, had to be postponed.

At this juncture, I would therefore like to congratulate the SEAFDEC Secretariat and Departments for their efforts to continue undertaking the committed activities as much as possible, the progress of which had been summarized in this SEAFDEC Annual Report 2020. I would also like to reiterate the support of the SEAFDEC Council for the plan of SEAFDEC to undertake the Study on the Impacts of COVID-19 Pandemic on the Fisheries Sector of the ASEAN-SEAFDEC Member Countries in 2021. As the COVID-19 is very critical situation, it is important for countries in the region to support each other by sharing information not only on the impacts, but also the adaptation and mitigation measures that had been developed and applied.

Specifically on the occasion of the publication of this SEADEC Annual Report 2020, and on behalf of the SEAFDEC Council, I would like to express our appreciation to SEAFDEC for carrying out its planned activities in 2020, and to partners and donor agencies for extending their continued support and cooperation to SEAFDEC throughout the year. Furthermore, on behalf of the Government of Japan, let me also express our continued commitment to support the programs of activities of SEAFDEC that dovetail towards the sustainable development of fisheries in the Southeast Asian region. We are looking forward to enhancing our closer cooperation with the rest of the SEAFDEC Member Countries in the coming years.

Takashi Koya

Mr. Takashi Koya
Deputy Director-General
Fisheries Agency of Japan

MESSAGE FROM THE SEAFDEC SECRETARY-GENERAL

The year 2020 marked the start of several new regional projects of SEAFDEC after the completion in 2019 of projects supported by the Government of Japan through the Japanese Trust Fund-VI and the SEAFDEC-Sweden Project. Such new regional projects of SEAFDEC also supported by Government of Japan, however continued and sustained the momentum of several regional initiatives and approaches developed and carried out through the previous projects. Furthermore, after the 10-year implementation of the Resolution and Plan of Action on Sustainable Development of Fisheries for Food Security for the ASEAN Region Towards 2020, this year had also been very significant for SEAFDEC with the adoption of the new regional policy framework—the Resolution and Plan of Action on Sustainable Development of Fisheries for Food Security for the ASEAN Region Towards 2030—where emerging issues and new challenges confronting the fisheries sector of the region were incorporated in the said document.

Although it has been a commitment for SEAFDEC to continue supporting the Member Countries, especially the ASEAN Member States, the implementation of the Resolution and Plan of Action Towards 2030 in 2020 appeared to be one of the most difficult years for the Member Countries of SEAFDEC in the midst of the COVID-19 pandemic that impacted people worldwide, including those engaged in the whole supply chain of the fisheries sector. In spite of the difficulties in the implementation of several activities, SEAFDEC still continued to exert its efforts to carry out the activities although the mode of the implementation has to be modified through online platforms.

This Annual Report 2020 therefore summarized the activities undertaken by SEAFDEC in collaboration with the Member Countries throughout the year. In this opportunity, I would like to express the sincere appreciation of SEAFDEC to all those who have provided support to our programs and activities, especially our collaborating partners. I would also like to express our gratitude to the SEAFDEC Member Countries, particularly the SEAFDEC Council of Directors for extending guidance on the operation of SEAFDEC throughout the past year. Furthermore, I would also wish to express our appreciation to the support of the Government of Japan, and other partners and donors not only in providing project funds but also for dispatching several experts to the region and share their knowledge and experiences that lead to the successful implementation of the SEAFDEC programs and activities.

It is the hope of SEAFDEC that the COVID-19 situation would be resolved soon so that the planned activities of SEAFDEC could be undertaken in full steam. Nonetheless, it is also our perpetual commitment to ensure that we continue to render our best efforts to address the priority issues on sustainable development and management of fisheries for the benefit of all.

Malin

Ms. Malinee Smithrithee
Secretary-General

LIST OF ACRONYMS

ACDS	ASEAN Catch Documentation Scheme
ACIAR	Australian Centre for International Agricultural Research
AFCF	ASEAN Fisheries Consultative Forum
AMAF	ASEAN Ministers on Agriculture and Forestry
AMSs	ASEAN Member States
AQD	SEAFDEC Aquaculture Department
APFIC	Asia-Pacific Fishery Commission
ASEAN	Association of Southeast Asian Nations
ASSP	ASEAN–SEAFDEC Strategic Partnership
ASWGFi	ASEAN Sectoral Working Group on Fisheries
AWP	Australian Water Partnership
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CPUE	Catch Per Unit Effort
CSU	Charles Sturt University, Australia
CTI-CFF	Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security
DA-BFAR	Bureau of Fisheries and Aquatic Resources, Department of Agriculture, Philippines
DACOFA	Data Collection for Fishery Application
DOF	Department of Fisheries
eACDS	Electronic ASEAN Catch Documentation Scheme
EAFM	Ecosystem Approach to Fisheries Management
EEZ	Exclusive Economic Zone
FAO	Food and Agriculture Organization of the United Nations
FCG	Fisheries Consultative Group
GEF	Global Environmental Facility
GIS	Geographic Information System
IFRDMD	SEAFDEC Inland Fishery Resources Development and Management Department
IUU Fishing	Illegal, Unreported and Unregulated Fishing
JAIF	Japan–ASEAN Integration Fund
JICA	Japan International Cooperation Agency
JIRCAS	Japan International Center for Agricultural Sciences
JTF	Japanese Trust Fund to SEAFDEC
MCS	Monitoring, Control and Surveillance
MFRD	SEAFDEC Marine Fisheries Research Department
MFRDMD	SEAFDEC Marine Fishery Resources Development and Management Department
MMAF	Ministry of Marine Affairs and Fisheries, Indonesia
MOU	Memorandum of Understanding
NFRDI	National Fisheries Research and Development Institute, Philippines

NOAA	U.S. National Oceanic and Atmospheric Administration
NRIFE	National Research Institute of Fisheries Engineering, Japan
PCA	Project Cooperation Agreement
PSM	Port State Measures
PSMA	Port State Measures Agreement
RDMA	Regional Development Mission for Asia, USAID
RIIFE	Research Institute for Inland Fisheries and Extension, Indonesia
RS	Remote Sensing
RFVR	Regional Fishing Vessels Record
RPOA	Regional Plan of Action
SFA	Singapore Food Agency
SEAFDEC	Southeast Asian Fisheries Development Center
SOM-AMAF	Senior Officials Meeting of the ASEAN Ministers on Agriculture and Forestry
SPEECTRA	Special Area for Conservation and Fish *Refugia*
SUFIA	Sustainable Fish Asia
SWG	Scientific Working Group
TOR	Terms of Reference
TD	SEAFDEC Training Department
UNEP	United Nations Environmental Programme
UNOPS	United Nations Office for Project Services
USAID	United States Agency for International Development
US-DOI	U.S. Department of Interior
WWF-US	World Wide Fund for Nature US

CONTENTS

ABOUT SEAFDEC

The Southeast Asian Fisheries Development Center (SEAFDEC) is an autonomous inter-governmental body established in 1967. SEAFDEC comprises 11 Member Countries: Brunei Darussalam, Cambodia, Indonesia, Japan, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam. The Center operates through the Secretariat located in Thailand and has five Technical Departments, namely: the Training Department; Marine Fisheries Research Department; Aquaculture Department; Marine Fishery Resources Development and Management Department; and the Inland Fishery Resources Development and Management Department. The mandate of SEAFDEC as endorsed by the Forty-first Meeting of the SEAFDEC Council is *"to develop and manage the fisheries potential of the region by rational utilization of the resources for providing food security and safety to the people and alleviating poverty through transfer of new technologies, research and information dissemination activities."*

The Secretariat

The SEAFDEC Secretariat is mandated to coordinate and oversee the general policy and planning of the Center, and acts as focal point for channeling and implementing the decisions and resolutions of the SEAFDEC Council of Directors. In addition, the Secretariat organizes the regular SEAFDEC meetings to obtain directives and guidance from the Member Countries on the operations of the Center, as well as regional technical consultations and meetings to address emerging issues as recommended by the Member Countries.

SEAFDEC Secretariat

The Training Department (TD)

Established in Thailand in 1968, TD has been focusing its efforts on the development of modern fishery techniques to aid regional fisheries in a more sustainable approach through the promotion of responsible fishing technologies and practices, exploration of resources, and advancing the coastal fisheries management approach. Under the new Strategic Plan which was endorsed by the SEAFDEC Council in 2006, the structure and activities of TD have been adjusted to emphasize on the promotion of coastal fisheries management to ensure responsible resource utilization and sustainable livelihoods in coastal communities, and off-shore fisheries through the development of best fishing practices and energy optimization technology to ensure stable supply of food fish and reduce fishing pressure in coastal areas.

SEAFDEC/TD

The Marine Fisheries Research Department (MFRD)

MFRD was established in Singapore in 1969 and is responsible for promoting, undertaking, and coordinating research in fisheries post-harvest technology and furthering the development of the fish processing industry in the Southeast Asian region. Its tasks include research and development on fisheries post-harvest technology and practices, such as fish processing technology to optimize the utilization of harvested fish and enhance the quality and safety of fish and fishery products. MFRD also develops technology-based analytical methods to assess seafood safety and quality, and publishes several manuals as reference materials for the Member Countries.

Since 2007, the Post-Harvest Technology Centre of the Agri-Food and Veterinary Authority (AVA), Singapore (PHTC/AVA) has been serving as the Collaborating Centre of SEAFDEC to undertake the activities of MFRD under the SEAFDEC Regional Programmes. However, with the formation of a new statutory board Singapore Food Agency (SFA) on 1 April 2019, the SFA continued to uphold Singapore's commitment to implement the MFRD programmes.

SEAFDEC/MFRD

The Aquaculture Department (AQD)

Established in the Philippines in 1973, AQD has been carrying out activities in aquaculture research, technology verification, training and information dissemination on a wide range of aquaculture disciplines, including broodstock management and seed quality improvement, promotion of responsible and environment-friendly aquaculture, diagnosis and control of aquatic diseases, aquaculture for stock enhancement, and culture of aquatic species under international concern. The aquaculture commodities covered by AQD include fishes, shrimps, mud crab, mollusks, and seaweeds. In addition, AQD also promotes good aquaculture practices and effective management of aquatic resources to support rural development and alleviate poverty.

SEAFDEC/AQD

The Marine Fishery Resources Development and Management Department (MFRDMD)

MFRDMD was established in Malaysia in 1992 to conduct activities on marine fishery resources focusing on biological studies of commercially important fish species, resource assessment and management, and conservation and management of aquatic species under international concern, *e.g.* sharks and rays. MFRDMD also implements activities that support the Member Countries, especially in the compilation of information on small pelagic species, and establishment of indicators that could be used for the sustainable development and management of fisheries.

SEAFDEC/MFRDMD

The Inland Fishery Resources Development and Management Department (IFRDMD)

Established in 2014 in Indonesia, IFRDMD is tasked to carry out activities that support the sustainable development and management of inland capture fisheries. The activities of IFRDMD include the development of methodologies for data collection, as well as monitoring and assessment of inland fishery resources to provide scientific basis for sustainable development and management of inland fisheries in the Southeast Asian region.

SEAFDEC/IFRDMD

SEAFDEC COUNCIL OF DIRECTORS IN 2020

Chairpersons of the SEAFDEC Council

Mr. Nilanto Perbowo *(until 19 May 2020)*
Mr. Shingo Ota *(since 19 May 2020)*

SEAFDEC Council and Alternate Council Directors

Brunei Darussalam

Council Director:	**Ms. Noraini Haji Anggas** Acting Director of Fisheries, Department of Fisheries
Alternate Council Director:	**Ms. Wanidawati Tamat** Acting Deputy Director of Fisheries, Department of Fisheries

Cambodia

Council Director:	**H.E. Eng Cheasan** Delegate of the Royal Government of Cambodia, and Director-General, Fisheries Administration
Alternate Council Director:	**Mr. Buoy Roitana** Deputy Director-General, Fisheries Administration

Indonesia

Council Director:	**Mr. Nilanto Perbowo** Secretary General, Ministry of Marine Affairs and Fisheries
Alternate Council Director:	**Prof. Sjarief Widjaja** Research and Human Resources, Ministry of Marine Affairs and Fisheries

Japan

Council Director:	**Mr. Shingo Ota** Councillor, Resource Management Department, Fisheries Agency, Ministry of Agriculture, Forestry and Fisheries
Alternate Council Director:	**Mr. Shige Watanabe** Director, First Country Assistance Planning Division, International Cooperation Bureau, Ministry of Foreign Affairs

Lao PDR

Council Director:	**Mrs. Vilayphone Vorraphim** Director-General, Department of Livestock and Fisheries
Alternate Council Director:	**Mr. Bounthong Saphakdy** *(until 23 February 2020)* Deputy Director-General, Department of Livestock and Fisheries **Mr. Chanthaboun Sirimanotham** *(since 24 February 2020)* Deputy Director-General, Department of Livestock and Fisheries

Malaysia

Council Director:	**Y Bhg Dato' Hj Munir bin Hj Mohd Nawi** *(until 25 October 2020)* Director-General of Fisheries Malaysia **Mr. Ahmad Tarmidzi bin Ramly, AMK** *(since 26 October 2020)* Director General, Department of Fisheries Malaysia
Alternate Council Director:	**Dato' Dr. Bah Piyan Tan** *(until 11 May 2020)* Deputy Director General (Management), Department of Fisheries Malaysia **Ms. Yeo Moi Eim** *(from 12 May 2020 until 25 October 2020)* Director of Planning and Development Division, Department of Fisheries Malaysia **Mr. Raja Bidin bin Raja Hassan** *(since 26 October 2020)* Deputy Director General (Fisheries Development), Department of Fisheries Malaysia

Myanmar

Council Director:	**Mr. Khin Maung Maw** *(until 3 March 2020)* Director-General, Department of Fisheries **Mr. Wai Lin Maung** *(since 4 March 2020)* Director-General, Department of Fisheries
Alternate Council Director:	**Mr. Myint Zin Htoo** Deputy Director-General, Department of Fisheries

Philippines

Council Director:	**Commodore Eduardo B. Gongona** Director of Bureau of Fisheries and Aquatic Resources, and Undersecretary for Fisheries, Department of Agriculture
Alternate Council Director:	**Mrs. Drusila Esther E. Bayate** Assistant Director for Technical Services, Bureau of Fisheries and Aquatic Resources

Singapore

Council Director:	**Dr. Tan Lee Kim** Director-General of Food Administration, and Deputy Chief Executive Officer, Singapore Food Agency
Alternate Council Director:	**Mr. Lim Huan Sein** Director of Aquaculture Department, Singapore Food Agency

Thailand

Council Director:	**Mr. Mesak Pakdeekong** Director-General, Department of Fisheries
Alternate Council Director:	**Mr. Bunchong Chumnongsittathum** Deputy Director-General, Department of Fisheries

Viet Nam

Council Director:	**Dr. Tran Dinh Luan** Deputy Director General of Directorate of Fisheries
Alternate Council Director:	**Mrs. Nguyen Thi Trang Nhung** Deputy Director, Department of Science, Technology and International Cooperation, Fisheries Administration, Ministry of Agriculture and Rural Development

SEAFDEC SENIOR OFFICIALS IN 2020

Secretary-General
Ms. Malinee Smithrithee
Deputy Secretary-General
Mr. Akito Sato (until 31 August 2020)
Mr. Koichi Honda (since 1 September 2020)

Training Department (TD)

Chief
Ms. Malinee Smithrithee
Deputy Chief
Mr. Akito Sato (until 31 August 2020)
Mr. Koichi Honda (since 1 September 2020)

Marine Fisheries Research Department (MFRD)

Chief, MFRD Programmes
Mr. Ong Yihang

Aquaculture Department (AQD)

Chief
Mr. Dan D. Baliao

Deputy Chief
Dr. Koh-ichiro Mori (until 30 June 2020)
Dr. Sayaka Ito (since 1 October 2020)

Marine Fishery Resources Development and Management Department (MFRDMD)

Chief
Mr. Raja Bidin Raja Hassan (until 16 August 2020)
Dr. Ahmad Ali (since 17 August 2020)
Deputy Chief
Dr. Masaya Katoh

Inland Fishery Resources Development and Management Department (IFRDMD)

Chief
Dr. Arif Wibowo
Deputy Chief
Dr. Takuro Shibuno (until 31 March 2020)
Dr. Toshiya Suzuki (since 1 April 2020)

OVERVIEW OF SEAFDEC PROGRAMS IN 2020

The activities of SEAFDEC in 2020 were formulated and implemented in line with the policy directives given by the SEAFDEC Member Countries during SEAFDEC annual meetings, *i.e.* the Forty-second Meeting of the SEAFDEC Program Committee (11–13 November 2019 in Chiang Mai, Thailand), Twenty-second Meeting of the Fisheries Consultative Group of the ASEAN–SEAFDEC Strategic Partnership (FCG/ASSP) (14–15 November 2019 also in Chiang Mai, Thailand), and the Fifty-second Meeting of SEAFDEC Council (Teleconference Session on 19 May 2020 and subsequent *ad referendum* Session).

SEAFDEC Council of Directors attending the teleconference session of the Fifty-second Meeting of the SEAFDEC Council

Moreover, the formulation and development of the SEAFDEC programs and activities for 2020 had also been guided by regional and international fisheries policy frameworks, particularly the "*Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2020,*" adopted by the ASEAN–SEAFDEC Ministers and Senior Officials during the ASEAN–SEAFDEC Millennium Conference in 2011. Furthermore, the programs and activities of SEAFDEC, especially those under the ASEAN–SEAFDEC Strategic Partnership (ASSP) established in 2007, also support the ASEAN in its efforts towards the realization of the ASEAN Economic Community, particularly the "*ASEAN Roadmap for Integration of the Fisheries Sector,*" the "*ASEAN Integrated Food Security (AIFS) Framework,*" and the "*ASEAN Fisheries Consultative Forum (AFCF).*" Nonetheless, under the SEAFDEC mechanism, the programs and projects of SEAFDEC, particularly those under the ASEAN–SEAFDEC Fisheries Consultative Group (FCG) had been categorized based on the "*SEAFDEC Strategies Towards 2030*" adopted by the SEAFDEC Council at its Special Meeting in 2017.

It should be noted however, that the progress of implementation of the programs and activities implemented by SEAFDEC in 2020, considered and endorsed by the Forty-third Meeting of the SEAFDEC Program Committee organized on 10–12 November 2020, and the Twenty-third Meeting of the Fisheries Consultative Group of the ASEAN–SEAFDEC Strategic Partnership (FCG/ASSP) on 17–18 November 2020, both Meetings arranged through teleconference sessions, would be submitted to the SEAFDEC Council at its Fifty-third Meeting in 2021. Such progress would be reported as the draft Annual Report 2020.

Participants of the Forty-third Meeting of the SEAFDEC Program Committee

Participants of the Twenty-third Meeting of the FCG/ASSP

The programs and projects implemented by SEAFDEC in 2020 are shown below:

1) Projects under the ASEAN-SEAFDEC FCG/ASSP Mechanism

Strategy/Project Title	Lead Department	Funding Source
Strategy I: Securing the sustainability of fisheries to contribute to food security, poverty alleviation and livelihood of people in the region		
1. Strengthening Regional Cooperation and Enhancing National Capacities to Eliminate IUU Fishing in Southeast Asia	TD	JTF
2. Harmonization and Enhancing the Utilization of Fishery Statistics and Information	SEC	JTF
3. Responsible Fishing Technology and Practice	TD	JTF
4. Research for Enhancement of Sustainable Utilization and Management of Sharks and Rays in the Southeast Asian Region	MFRDMD	JTF
5. Sustainable Utilization of Anguillid Eels in the Southeast Asian Region	IFRDMD	JTF

Strategy/Project Title	Lead Department	Funding Source
6. Sustainable Utilization of Fisheries Resources and Resources Enhancement in Southeast Asia	TD	JTF
7. Fisheries Management Strategies for Pelagic Fish Resources in the Southeast Asian Region	MFRDMD	JTF
8. Management Scheme for Inland Fisheries in the Southeast Asian Region	IFRDMD	JTF
9. Small-scale Fisheries Management for Better Livelihood and Fisheries Resources	TD	JTF
10. Establishment and Operation of a Regional System of Fisheries *Refugia* in the South China Sea and Gulf of Thailand	TD	UNEP/GEF
11. 10.Strengthening the Effective Management of Inland Fisheries and Aquaculture in AMSs with GIS and RS Technology	SEC	JAIF
12. Development of Stock Assessment Methods and Strengthening of Resources Management Measures for Tropical Anguillid Eel in Southeast Asia	SEC	JAIF
Strategy II: Supporting the sustainable growth of aquaculture to complement fisheries and contribute to food security, poverty alleviation and livelihood of people in the region		
13. Sustainable Aquaculture through Cost-effective Culture Systems, and Prompt and Effective Aquatic Animal Health Management	AQD	JTF
Strategy III: Ensuring the food safety and quality of fish and fishery products for the Southeast Asian region		
14. Enhancing Food Safety and Competitiveness of Seafood Products	MFRD	JTF
Strategy IV: Enhancing trade and compliance of the region's fish and fishery products with market requirements		
-		
Strategy V: Addressing cross-cutting issues, such as labor, gender and climate change, where related to international fisheries		
15. Assistance for Capacity Development in the Region to Address International Fisheries-related Issues	SEC	JTF
Strategy VI: Empowering SEAFDEC to strengthen its roles in the region and to improve its services to Member Countries		
16. Fisheries Resource Survey and Operational Plan for M.V. SEAFDEC 2	TD	JTF

2) Departmental Programs

Program Title	Department	Funding Source
1. Quality Seed for Sustainable Aquaculture	AQD	AQD*
2. Healthy and Wholesome Aquaculture	AQD	AQD*
3. Maintaining Environmental Integrity through Responsible Aquaculture	AQD	AQD*
4. Meeting Social and Economic Challenges in Aquaculture	AQD	AQD*
5. Adapting to Climate Change Impacts	AQD	AQD*
6. Collaborative Projects with the Philippine Government	AQD	AQD*
7. Promotion on Strengthening of SEAFDEC Visibility and Enhancing Human Capacity Building	TD	TD*
8. Improvement of Fisheries Technology and Reduction of the Impact from Fishing Activities	TD	TD*
9. SEAFDEC Capacity Development through USAID Sustainable Fish Asia Activity	TD	USAID
10. Modernizing Irrigated Agriculture to Protect and Restore Aquatic Biodiversity and Ecosystem Services in South-East Asia	IFRDMD	FAO

*Funding for Departmental Programs is mainly sourced from regular contributions of respective Host Governments

3) Other Programs

Program Title	Department	Funding Source
1. Implementing the Lower Mekong Fish Passage Initiative in Cambodia, Thailand, and Viet Nam	TD	US-DOI
2. Gender Dimension in the Value Chain of Small-scale Fisheries & Aquaculture in Southeast Asia	TD	FAO
3. Implementing the Strategic Action Programme for the South China Sea and Gulf of Thailand	TD	UNEP/GEF

SEAFDEC PROGRAMS OF ACTIVITIES IN 2020

Every year, the programs of activities of SEAFDEC have always been formulated and undertaken in response to the requirements of the Member Countries. This was the same for the year 2020, notwithstanding the need to consider the priority issues stipulated in the "*Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2020*" adopted in 2011, and also adhere to the "*Resolution on the Future of SEAFDEC: Vision, Mission, and Strategies Towards 2030*" adopted by the SEAFDEC Council during its Special Meeting in 2017. Thus, the programs and activities carried out by SEAFDEC in 2020 had been structured based on the "*SEAFDEC Strategies Towards 2030,*" *i.e.* 1) Securing the sustainability of fisheries to contribute to food security, poverty alleviation and livelihood of people in the region; 2) Supporting the sustainable growth of aquaculture to complement fisheries and contribute to food security, poverty alleviation and livelihood of people in the region; 3) Ensuring the food safety and quality of fish and fishery products for the Southeast Asian region; 4) Enhancing trade and compliance of the region's fish and fishery products with market requirements; 5) Addressing cross-cutting issues, such as labor, gender and climate change, where related to international fisheries; and 6) Empowering SEAFDEC to strengthen its roles in the region and to improve its services to Member Countries. Furthermore, Special Projects have also been implemented by SEAFDEC to address cross-cutting issues but due to their nature, these were not categorized under any particular Strategy.

The year 2020 has not been an easy year to conduct R&D activities, and as experienced worldwide, SEAFDEC also encountered difficulties in implementing the workplans under its programs and projects for 2020 due to the coronavirus (COVID-19) pandemic. Although SEADEC was able to carry out some national activities as planned, especially in the countries hosting the respective SEAFDEC Departments, most regional activities had been carried out through on-line platforms while those activities that require in-person participation and discussion, have to be postponed for 2021.

The results and progress of the programs and activities of SEAFDEC implemented in 2020 that include those under the ASEAN–SEAFDEC FCG/ASSP Mechanism, Departmental Programs, and Other Programs, are summarized as follows:

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

1.1 Assessment and management of marine fish stocks

Sustainable Utilization of Fisheries Resources and Resources Enhancement in Southeast Asia

The role of fisheries in the socio-economic development of the countries all over the globe is widely recognized. Production from marine fisheries is known to provide the primary sources of protein for people and contribute to the livelihoods of various groups of stakeholders, *i.e.* fishers, traders, processors, and so on. Recently, several Southeast Asian countries are among the world's top producers of fish and fishery products. Throughout the past

decades, the demand for marine fishery products at the international, regional and national levels had been increasing leading to the continued development and modernization of fishing technologies to maximize fish catch. However, such action has in turn resulted in the over-exploitation of several marine fishery resources. The governments of the Southeast Asian countries therefore made sure that the root cause of any possible decline in their fisheries production is addressed to ensure the sustainability of their respective fisheries sector, and that of the whole Southeast Asian region.

One of the concerns brought forward by most Southeast Asian countries is on the need to enhance the fishery resources in their waters and to explore their respective under-utilized offshore fishery resources. Through its programs and projects, SEAFDEC has been providing technical support to the Southeast Asian countries in their efforts towards addressing such concerns, especially through the new 5-year project **"Sustainable Utilization of Fisheries Resources and Resources Enhancement in Southeast Asia,"** embarked by SEAFDEC/TD in 2020 which include regional consultation meetings and capacity development training courses, conduct of research surveys, development of the application of Fisheries Geographic Information System (FGIS) and Remote Sensing (RS), as well as enhancement of the fishery resources and habitats, and development of plans of action at the regional and national levels.

For the sustainable utilization of marine resources, a significant activity carried out by TD is the "Regional Consultation Teleworkshop on the Utilization of Fisheries Geographic Information System (FGIS) and Remote Sensing (RS) to Improve Fisheries Management in Southeast Asia," which was organized on 20 August 2020 through an online platform. A total of 36 participants including representatives from the ASEAN Member States (AMSs) and SEAFDEC Departments attended the Workshop which aimed to gather updated information on studies and research on utilization of GIS and RS technology in fisheries and environmental science in the region, discuss the activities on human resource development to be undertaken during 2021–2023 under the Project, and establish the FGIS and RS network in the region. Based on the information provided by the participants, so far during the past two decades, there had been 26 accomplished and 24 ongoing studies and research on fisheries, fisheries management, and environmental science in the Southeast Asian region that applied the GIS and RS technology.

The "Online Regional Training Course on Sampling Gear Design for Onboard Fisheries Resource Survey" was also organized by TD from 31 August to 4 September 2020 as part of SEAFDEC's initiatives to support the AMSs in developing the capacities of their human resources in conducting fisheries resource surveys and establishing fisheries resource survey network in the region. There were 19 participants including fisheries officers from the AMSs at the Training, which focused on sampling gear selection, fishing gear design, sampling process and data recording, CPUE standardization, and fishery resource survey design. At the end of the Training, the participants gained knowledge that could be applied in carrying out of fishery resource surveys in their respective countries. Moreover, the fishery resource survey network was initiated to enable the trainees to directly consult with the region's experts.

Meanwhile, in order to address the concerns on transboundary fishery resources, TD conducted the "Sub-regional Consultation Teleworkshop on Developing a Plan of Activity for Transboundary Fisheries Resources" from 27 to 28 August 2020. Organized through an online platform, the Consultation was mainly meant for the development of the plan of activities for transboundary fishery resources in the Gulf of Thailand and Sulu-Sulawesi Seas. The 37 participants in the Workshop included the resource persons and representatives from the SEAFDEC Member Countries and SEAFDEC Departments. Mainly focusing on the identification of the necessary activities to address issues on transboundary fishery resources issues, the Workshop came up with an agreement on the sustainable management of economically important fishery resources, such as short mackerel, anchovies, and neritic tunas for the Gulf of Thailand sub-region; and on neritic tunas in the Sulu-Sulawesi Seas sub-region. The Workshop also agreed that TD should continue to provide capacity building to the countries in 2020–2024, especially on Yield Per Recruit Model and Feedback Control.

On enhancement of fishery resources and their habitats, TD conducted the "Regional Consultation Workshop on Developing a Plan of Activities for Resource Enhancement in Southeast Asian Region" on 15 September 2020. Also conducted through an online platform, the Workshop was intended to develop the plan of activities for resources enhancement including training courses, research studies, meetings, workshops, and others. There were 30 participants including the National Focal Points from the AMSs and technical staff from TD, attending the Workshop which came up with recommendations including the conduct of capacity building activities, development of platform for sharing of knowledge and scientific evidence, and promotion of sustainable fisheries management practices.

Online Regional Training Course on Sampling Gear Design for Onboard Fisheries Resource Survey (31 August to 4 September 2020, Samut Prakan, Thailand)

Regional Consultation Teleworkshop on the Utilization of Fisheries Geographic Information System (FGIS) and Remote Sensing (RS) to Improve Fisheries Management in Southeast Asia (20 August 2020, online meeting)

Sub-regional Consultation Teleworkshop on Developing a Plan of Activity for Transboundary Fisheries Resources (27–28 August 2020, online meeting)

Regional Consultation Workshop on Developing a Plan of Activities for Resource Enhancement in Southeast Asian Region (15 September 2020, online meeting)

Fisheries Management Strategies for Pelagic Fish Resources in the Southeast Asian Region

In 2020, SEAFDEC/MFRDMD embarked on a new regional project **"Fisheries Management Strategies for Pelagic Fish Resources in the Southeast Asian Region"** for 2020–2024 with the aim of evaluating the pelagic fish resources in the Southeast Asian region to establish a sustainable management strategy for the resources. Transboundary fish species, such as mackerels, tunas, and scads, are the major target species for this Project because of their abundance in the AMSs and the need to establish efficient fisheries management strategies of the respective stocks. This Project also involves genetic study of one target pelagic species in the region, as well as a study on the life history of the species through age determination analysis. With the responsibility of providing information and samples for the Project, the participating AMSs include Brunei Darussalam, Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Thailand, and Viet Nam.

In 2020, MFRDMD organized the "First Core Experts Meeting on Fisheries Management Strategies for Pelagic Fish Resources in the Southeast Asian Region" on 24 November 2020 through an online platform. Representatives from Brunei Darussalam, Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Thailand, and Viet Nam; resource persons from Japan and Malaysia; representatives from SEAFDEC Secretariat, TD; and the Chief, Deputy Chief and Officials from MFRDMD attended the Core Experts Meeting, which was aimed at sharing the findings and outputs of the previous project on pelagic fishery resources undertaken by MFRDMD, introducing the new Project to be undertaken from 2020 to 2024, and obtaining the views of the participants on the activities and way forward for the Project.

First Core Experts Meeting on Fisheries Management Strategies for Pelagic Fish Resources in the Southeast Asian Region, organized on 24 November 2020 through an online platform: (above) *participants from MFRDMD; and* (left) *resource persons, and participants from the other SEAFDEC Departments and AMSs*

This new Project would primarily focus on two groups of pelagic fishes, *i.e.* neritic tunas and small pelagic species. For neritic tunas, the two focus species are kawakawa (*Euthynnus affinis*) and longtail tuna (*Thunnus tonggol)*; while for small pelagic species, these would be subject to the priority of the AMSs. Prior to the Core Experts Meeting, a questionnaire was disseminated to the countries; and from the responses, the Core Experts Meeting subsequently agreed that the Project should focus on three small pelagic species, namely: *Rastrelliger kanagurta*, *R. brachysoma*, and *Decapterus* spp. The Meeting also recommended that each participating country should designate two focal persons for the Project.

Under the Project, the preliminary study on establishing the life history of neritic tunas was initiated by collecting 470 specimens of kawakawa from the coastal waters of Tok Bali, Kelantan, Malaysia during the period from January to November 2020. Otoliths were extracted and their ages were determined by observing/reading the annual rings on the otolith. However, only 204 otoliths were good enough for annual ring observation. Overall, the results indicated that the specimens ranged from one to nine years old. Specifically, 39 specimens were three years old, 37 were four years old, and 35 specimens were five and six years old. Only three specimens had ages that were assumed to be one year old. The study would be continued in 2021 by adding additional specimens, *i.e.* increasing from 50 specimens per month collected in 2020 to 60 specimens per month in 2021.

Also in 2020, results of the works of the Scientific Working Group for Stock Assessment on Neritic Tunas in the Southeast Asian Region (SWG–Neritic Tunas) previously established and supported by the SEAFDEC–Sweden Project during 2013–2019 would be used by this new project to evaluate the current stock status of two neritic tuna species through stock assessment and risk assessment studies. During the "Sixth Meeting of the Scientific Working Group on Neritic Tunas Stock Assessment in the Southeast Asian Waters" conducted on 2 December 2020 through an online platform, the revised Terms of Reference (TOR) of the SWG–Neritic Tunas, which was endorsed by the SEAFDEC Council at its Fifty-second Meeting in 2020 was presented, particularly to expand the TOR of the SWG to include other important pelagic fishes. In addition, the SWG agreed on the results of the stock assessment of kawakawa and longtail tuna in this region had also been updated by comparing the results of two workshops conducted in 2016 (using the data up to 2014) with the recent workshop organized in February 2020 (using the data up to 2018). In the latter analysis, it was found that the stock status for longtail tuna in the Indian Ocean was in a safe situation (green zone) compared to previous assessments in 2016, which indicated a severe overfished situation (red zone). Meanwhile, in the Pacific Ocean, longtail tuna remains in a safe situation (green zone) similar to the status found in the previous assessment in 2016. As for kawakawa, the stock status in the Indian Ocean showed to be overfished (red zone) from the latter assessment compared with the results of the assessment in 2016, which showed a safe situation (green zone). Nonetheless, the stock status of kawakawa in the Pacific Ocean in the latter analysis remains in a safe situation, similar to that of the 2016 stock assessment. The results would be subsequently submitted at the Fifty-third Meeting of SEAFDEC Council in 2021 and the ASEAN mechanism.

Participants in the Sixth Meeting of the Scientific Working Group on Neritic Tunas Stock Assessment in the Southeast Asian Waters on 2 December 2020

Also during the Sixth SWG–Neritic Tunas Meeting, results of the population study of longtail tuna, *Thunnus tonggol* in the Southeast Asian region conducted with support from the Department of Fisheries Malaysia, were presented. The study was aimed at: i) identifying the level of genetic diversity of *T. tonggol* in the Southeast Asian region and the Andaman Sea; and ii) determining the genetic structure of *T. tonggol* using microsatellite DNA markers. A total of 373 specimens from ten sampling sites (using the same specimens from the previous study funded by the SEAFDEC-Sweden Project from 2016 to 2018) were analyzed based on mitochondrial DNA regions (Displacement loop and Cytochrome B). The results showed that all populations have high genetic diversity and the test for genetic bottleneck did not detect any significant bottleneck effects. Furthermore, from the population structure analyses, no subpopulations could be distinguished as supported by a high genetic exchange among the sampled localities. This result supports the previous finding analyzed by mitochondrial DNA markers (*D-loop* and *Cyt b*).

One of the main activities of this project involves compiling and analyzing the historical catch and effort data, which are especially crucial for estimating the stock status of small pelagic species and neritic tunas. It is therefore recommended that all AMSs should improve their statistical data collection based on SOP on Data Collection published by SEAFDEC.

In order to disseminate the information that emanate from the Project, MFRDMD will publish two meeting reports in 2021, namely: 1) Report of the First Core Experts Meeting on Fisheries Management Strategies for Pelagic Fish Resources in the Southeast Asian Region, and 2) Report of the Sixth Meeting of Scientific Working Group on Neritic Tunas Stock Assessment in the Southeast Asian Waters.

1.2 Assessment and management of inland fisheries

Management Scheme for Inland Fisheries in the Southeast Asian Region

In Southeast Asia, inland fisheries are among the most economically important sub-sectors at the local and national levels because of their contribution to food security and the

improved incomes in rural communities. However, information on production from inland capture fisheries in the region has always been very limited due to the nature of inland fishing operations which is mostly small-scale, highly seasonal, and primarily carried out by part-time fishers, and large part of the production is meant for domestic consumption and not recorded at landing sites. Nevertheless, countries in the region have been exerting efforts to improve their systems of compiling data and information on inland fisheries to understand the status of the sub-sector and its contribution to the countries' economies. Such efforts have been supported through the various projects implemented by SEAFDEC/IFRDMD to enable the AMSs to efficiently compile data and information on their respective inland fisheries.

To sustain such initiatives of improving data/information collection and supporting management for the sustainability of inland fisheries in the region, IFRDMD embarked on its new regional five-year project in 2020 **"Management Scheme of Inland Fisheries in the Southeast Asian Region,"** for 2020 to 2024. The Project comprises activities that dovetail toward two expected outputs, namely: 1) Policy and recommendations for inland fisheries management in Southeast Asia; and 2) Assemblage of fish catch data and information, including publication of the manual on collection and sampling of inland fish biological characteristics. The study site for 2020 focused only in Indonesia, *i.e.* in South Sumatera and Riau.

- *Policy and recommendations for inland fisheries management in Southeast Asia*

Under this component, IFRDMD introduced a Special Area for Conservation and Fish *Refugia* or SPEECTRA, which was designed to be a model on inland fisheries management in Indonesia and Southeast Asia. SPEECTRA is also expected to serve as artificial fishery sanctuary that functions as fish shelter (spawning, nursery and feeding ground) as well as fish production reserve in the future.

In 2020, three pilot models of SPEECTRA were set up in South Sumatera Province of Indonesia. Socialization on the establishment of SPEECTRA to the public was conducted on 17 October 2020 by IFRDMD and the Research Institute for Inland Fisheries and Extension (RIIFE) of Indonesia at a marginal flood plain in Patra Tani, Muara Enim, South Sumatera.

Socialization on the establishment of SPEECTRA

As of the end of 2020, three SPEECTRAs were established with the total area of 4.0 ha, namely: 1) SPEECTRA 1 has an area of 1.0 ha and is surrounded by traps ("hampang"); 2) SPEECTRA 2 with an area of 1.0 ha is surrounded by a connectivity canal; and 3) SPEECTRA 3 with an area of 2.0 ha surrounded by connectivity canal and five artificial ponds. Every month, the staff of IFRDMD and RIIFE collect information on water level, water quality parameters (dissolved oxygen (DO), CO_2, and temperature), and biological information of fishes in each SPEECTRA.

SPEECTRA 1 model

The first model, SPEECTRA 1 was established by RIIFE during the later part of 2019, and stocked with 37 kg of fish, and in 2020 with 130 kg of fish. The fish species stocked were *Helostoma temminckii* ("tembakang"), *Belontia hasselti* ("selincah"), *Trichogaster pectoralis* ("sepat siam"), *Trichopodus trichopterus* ("sepat mata merah"), *Anabas testudineus* ("betook"), *Notopterus notopterus* ("putak"), *Pangasius* sp. ("patin"), *Pristoplepis fasciata* ("sepatung"), *Channa pleurophthalma* ("serandang"), and *Clarias batrachus* ("lele").

SPEECTRA 2 model

The second model, SPEECTRA 2 was built by the RIIFE in collaboration with IFRDMD and the Ministry of Forestry and Environment of Indonesia on 2020. IFRDMD stocked 50 kg of fish such as *Helostoma temminckii*, *Trichogaster pectoralis*, *Trichopodus trichopterus*, and *Anabas testudineus*. In this model, there are many trees and grasses around the pond which serve as refuge for fish to spawn and grow. The concept was inspired by the silvofishery system of Indonesia that allows rearing of both aquatic animals and trees within the same pond. Moreover, SPEECTRA 3 was established by IFRDMD in mid 2020, merging the concepts used in SPEECTRA 1 and SPEECTRA 2. In this model, 100 kg of fish was stocked by RIIFE.

SPEECTRA 3 model

Starting in June 2020, IFRDMD hired three enumerators to collect data from SPEECTRA 1 every month, such as data on fish production and length–weight of fish catch. The fish samples were taken from a pool inside SPEECTRA 1 and from its outlet. The enumerators noted that the fish are caught using "pengilar" (trap), "sengkirai" (trap), and "jala" (cash net). The fishing gear "sengkirai" (trap) was used for monitoring the fish larvae that come out from the SPEECTRA and go to the canal which is connected to the main river. IFRDMD and RIIFE expect that the fish larvae from SPEECTRA would grow into marketable sizes and contribute to increasing the protein source for the surrounding communities.

Based on the data collected from SPEECTRA 1, three types of fish groups were caught: labyrinth, snake head, and catfish. The labyrinth fishes are the most dominant during the monthly monitoring, and comprise *Trichogaster pectoralis*, *Trichogaster trichopterus*, *Anabas testudineus*, *Helostoma temminckii*, and *Belontia haselltii*. The catch of *Trichogaster pectoralis* and *Trichogaster trichopterus* comprised the highest fish production, suggesting that the SPEECTRA 1 has been functioning. Furthermore, the fish stocked in 2019 had grown and some had spawned.

Results of the water quality monitoring indicated that the average pH in the SPEECTRA is close to 5.0, and since the low-level pH affects the Dissolved Oxygen (DO) so in this case, the level of DO had decreased. In such a situation, water circulation in the SPEECTRA needs more attention by checking the pH and DO of the water more regularly. Besides, the continuous flushing of water in inlet–outlet could prevent the oxidation of the pyrite layer on acidic soils.

As one of the management tools for fishery resources assessment, the Data Collection for Fishery (DACOFA) application designed by IFRDMD has enabled fishers and other users to input data on inland capture fisheries quickly and efficiently using their smartphones, and the data are automatically recorded in the IFRDMD database. IFRDMD started to conduct pilot testing of the application of DACOFA in Patra Tani, South Sumatera in Indonesia. A smartphone installed with the DACOFA application from Google Playstore was given to an enumerator, who had been trained by researchers and staff of the IFRDMD Data Center on how to operate and input the data using the DACOFA.

A smartphone with DACOFA given to an enumerator (left)*; and training on DACOFA application in Patratani, South Sumatera, Indonesia* (right)

- *Assemblage of Fish Catch Data and Information*

A data collection survey was conducted on 10–13 February 2020 in Riau, Indonesia by a survey team comprising researchers from IFRDMD, Riau University, and the Ministry of Marine Affairs and Fisheries. The survey was meant to assess the biodiversity of inland fisheries and to collect data from Kampar River in Riau Province. The Province has served as one of the sites of various pilot projects because of the high fisheries potentials from its inland fishery resources. The fisheries sector of the Province is a significant contributor to the economy of Riau particularly in Kampar District, which is particularly important for poverty alleviation, food security and nutritional well-being of many rural communities in Kampar. Nevertheless, while production from the aquaculture sector had increased rapidly, that of inland capture fisheries had been decreasing. As the sustainability of inland capture fisheries is dependent on the quality of aquatic habitats and ecosystems, information on the status and trends of freshwater fish resources are therefore necessary for the sustainability of inland fisheries management. As one of the local initiatives to improve the awareness of inland fisheries and enhance the conservation and management of the ecosystems for the sustainability of inland fisheries, the local fishers' community of Kampar has been establishing fisheries protection areas in inland water ecosystems such as in lakes (Lubuk Larangan and Makuok Oxbow Lake). However, the aquatic resources of Kampar inland fisheries are still under threat from environmental degradation and poor management practices.

Various species of fish landed at Kampar landing site

To support the collection of information on the status and trends of freshwater fish resources in this pilot site, IFRDMD collected fish production data by each fishing gear used by fishers in Kampar River. After the production for each fishing gear by the time (month) was grouped, the trend and the fluctuation production for each gear were evaluated. Results showed that eight of the fishing gears have different characteristics in terms of the materials used, installation processes and the species targeted. Production from using "lukah" (trap) for example, was high in February but decreased in March and rose up again in April. Nevertheless, it was also observed that the production in March was very low because data collection had almost stopped during that month because of the COVID-19 pandemic. The results also indicated that the highest production of 2,146.2 kg was attained with the use of "pancing rawai" (line). In general, there was fluctuation of the production of each fishing gear during the observation period, which was noted from the differences in the quantity of the target fish caught. The total production during the sampling reached its highest of 2,310.7 kg in August but this went down after August to 868 kg.

In this research study, 23 fish species were caught using eight fishing gears. The composition of fish caught could increase after longer time sampling period. The composition of fish caught from Kampar River was not only whitefish, but also blackfish such as "gabus" *Channa striata*, "bulan- bulan/kepituk" *Helostoma temminckii*, "sepat siam" *Trichogaster pectoralis*, and "gesso" *Hemibagus* sp. The total species caught in Kampar River was more compared to that from the Kotopanjang Reservoir located in the upstream of Kampar River. The sampling location was located in the middle part of Kampar River basin, which becomes a buffering ecosystem that mixes the water from the wetlands and the main body of the River. The largest population of whitefish caught was "motan" *Tynnichys polylepis* with a catch of 2,354.2 kg. This species belongs to the cyprinidae group of fishes that lives in freshwater habitats such as lakes, rivers and canals with shallow water. This species has a large distribution in Sumatera and Kalimantan (Borneo) Island. People catch this species to be processed into salted fish or sold fresh. Another whitefish that becomes a target for fishing is "baung" *Mystus nemurus*, which has high commercial value, sold at high price but highly in demand in the market. Fishers catch this species using "pancing rawai" (line) and "lukah" (trap net) with specific baits.

During the study, species of blackfish were also found under the unique condition of the sampling site in Kampar River, indicating that the sampling location is not only inhabited by groups of whitefish but also blackfish (swamp). The large catch of blackfish species was "gabus" (*Channa striata*) and "bulan-bulan" (*Helostoma temminckii*). Gabus is a top predator on the tropic state of the food chain, and this species is the main target for fishers who use "pancing rawai" (line). With the high benefit, good taste and high price in the market, "gabus" has been exploited for a long time.

Strengthening the Effective Management of Inland Fisheries and Aquaculture in AMSs with GIS and RS Technology

Geographic Information System (GIS) and Remote Sensing (RS) technologies are essential instruments for visualization, monitoring, and assessment of the resources, the results of which could be used in preparing appropriate planning and management strategies for the

sustainable utilization of the resources. Usage of these technologies has been explored by various researchers, especially in obtaining the necessary information to support the formulation of appropriate approaches, policies, as well as management plans for medium- and long-term sustainability of the resources. To further investigate the application of these technologies in the context of inland fisheries and aquaculture in the Southeast Asian region, SEAFDEC implemented the project **"Strengthening the Effective Management of Inland Fisheries and Aquaculture in AMSs with GIS and RS Technology"** since 2019 with support from the Japan–ASEAN Integration Fund (JAIF).

This project, which was originally planned for implementation from January 2019 to June 2020, is aimed at developing the methods for monitoring inland fisheries and aquaculture using GIS Mapping and RS technologies, and investigating the relationship between the amount of catch and the environmental data through GIS mapping. Five project pilot sites were selected in the AMSs, namely: Tonle Sap Great Lake in Cambodia, Sentarum Lake in Indonesia, Nam Ngum Reservoir in Lao PDR, Akwi In in Myanmar, and Bangrakum Floodplain in Thailand, with the planned activities that include: 1) collection of catch data using logbook of fishers in the five selected sites; 2) collection of environmental data from satellite images; and 3) analyzing the relationship between catch data and environmental factors.

In 2020, data collection from fishers' logbook which started in April 2019 at the five project sites were continued by enumerators at the respective sites until the completion of data collection in July 2020. In addition, environmental parameters, *e.g.* inland water area, water surface temperature, rainfall, chlorophyll-a, were also compiled. As planned, these catch and environmental data would be analyzed using multivariate analysis to establish the relationship between catch and the environmental factors. However, as the working group meeting for data analysis could not be convened as planned due to the COVID-19 pandemic, the project duration was therefore extended until December 2021.

During the second half of 2020, the project team conducted field visit to the project site at Bangrakum Floodplain in Phitsanulok Province, Thailand on 5–7 November 2020, to verify the catch and environmental data. The verification undertaken by the project team together with the enumerators from the Department of Fisheries (DOF) of Thailand, focused on the data recorded in the logbook that included the identification of the types of fishing gear used in catching fish, and checking/correcting of the errors that might have occurred during the inputting of the data. The project team also interviewed the fishers and observed the fishing conditions and the ground situation using GPS, of the 13 sampling points at the sites, and collected data on water temperature and the sites' coordinates for verification of the environmental data. Multivariate analysis was then carried out to establish the relationship between the catch and environmental data, and discussion on the analytical approach using GIS/RS technology was initiated. Statistical analysis of the data would be continued in 2021.


Field survey in Phitsanulok Province Thailand: fisher confirming the fishing gears' locations (left)*, and project team collecting water samples* (right)

The remaining activities to be undertaken during the extended period in 2021 include data verification at the remaining sites and data analysis based on the data submitted by the enumerators. A technical manual on analytical methods using GIS/RS techniques would be developed based on the best data collection processes as exemplified through this project, for dissemination and possible adoption in the AMSs. A workshop to discuss on the use of GIS/RS technology and analytical methods, and the project-end-meeting to present the findings from this project would also be organized.

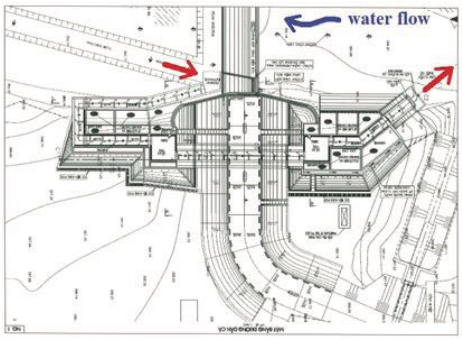
Implementing the Lower Mekong Fish Passage Initiative in Cambodia, Thailand, and Viet Nam

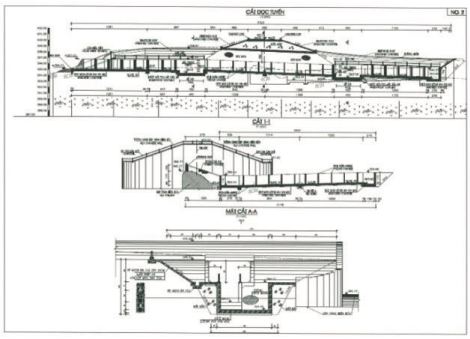
In an effort to enhance the sustainability of inland fishery resources by mitigating the impacts of cross-river constructions, the Project **"Implementing the Lower Mekong Fish Passage Initiative in Cambodia, Thailand, and Viet Nam"** was carried out by TD from 2018 to September 2020. With support provided by the United States Department of Interior (US-DOI) and the United States Agency for International Development (USAID), the Project was aimed at building the capacity of the SEAFDEC and Lower Mekong River Basin nations to construct and maintain low head fish passes to restore the fishery connectivity at irrigation facilities, weirs, and road prisms. In 2019, the Project had completed the construction of Kbal Hong fish passage in ***Cambodia*** so that the activities in 2020 focused mainly in Thailand and Viet Nam sites.

In ***Thailand***, the construction of fish passage at Hauy Wang Chang Weir, Sangkom District, Udon Thani Province which started in December 2019 was completed in April 2020. The technical team from TD inspected the site on 12–15 June 2020 to observe the performance of the constructed fish passage during the first rainy season with water inflow, and the endurance of crushed stone at the bottom of the fish passage exit. The efficiency of fish passage in allowing up-stream migration of fish at the beginning of the raining season was also noted. However, as some erosions occurred in the waterway bank beside the fish passage, TD in consultation with the fish passage working team of Thailand therefore decided to make additional improvements by constructing a concrete wall that would block the overflow on top of the weir, and install surface crash stone along the fish passage, as recommended by the Australasian Fish Passage Services. These additional improvements were completed on 1 October 2020.

Fish passage construction at Hauy Wang Chang Weir, Udon Thani Province, Thailand (left)*, and setting of fish trap at the exit pool of fish passage to observe its efficiency for fish migration* (right)

As for ***Viet Nam***, the Directorate of Fisheries (D-Fish) in 2020 authorized the Department of Agriculture & Rural Development (DARD) of Đắc Lac to be responsible for designing and implementing the fishway construction project. The vertical slot fishway design was selected as a demonstration for fishway construction at Ea Tul weir in Ban Don District, Đắc Lac Province. A review of the fishway design by DARD in consultation with USAID/DOI fishway engineers was submitted to the Đắc Lac Provincial Committee for approval. The Đắc Lac Provincial DARD People's Committee proposed to assign the Director of Đắc Lac Provincial DARD as Provincial Focal Point to coordinate the Lower Mekong Basin, Low-Head Fish Passage Initiative. To proceed with the construction of the fishway, TD signed a Letter of Agreement with Đắc Lac Provincial DARD to support the fishway construction, which started in October 2020. Since the construction of the fishway in Viet Nam started later, the duration of this Project was therefore extended until September 2021.





Fishway design adopted by DARD in consultation with USAID/DOI fishway engineers

Modernizing irrigated agriculture to protect and restore aquatic biodiversity and ecosystem services in South-East Asia

In 2020, IFRDMD implemented the Departmental Program **"Modernizing Irrigated Agriculture to Protect and Restore Aquatic Biodiversity and Ecosystem Services in Southeast Asia,"** which was funded by the Australian Water Partnership (AWP) and implemented in collaboration with the Charles Sturt University (CSU). AWP is an international cooperative initiative that helps developing countries in the Indo-Pacific region, and beyond, to work towards the sustainable management of their water resources, and actively support the UN sustainable development goals. As part of the AWP initiative, this Program was aimed at promoting and implementing the fish passage concept as an engineering solution to maintain connectivity in existing weirs and dams throughout Indonesia.

Under this Program, IFRDMD in collaboration with RIIFE organized the "Workshop on Water Resources Management to Secure Aquatic Biodiversity for Sustainable Development" for officials from the Indonesian Ministry of Marine Affairs and Fisheries and Ministry of Public Works and Housing on 5 October 2020 in Palembang, Indonesia. The Workshop participants came from BBWS VIII Sumatera, Public Works and Irrigation Office of South Sumatera Province, East Ogan Komering Ulu Fishery Office, and fishers. Through this Workshop, knowledge was shared on the fish passage model that will be implemented by IFRDMD and RIIFE, as well as on the irrigation schemes. Through the Workshop, it was confirmed that the development of water infrastructures to increase rice production could continue without negatively affecting the fishery resources. Furthermore, the participants were expected to spread the knowledge gained to other stakeholders in order to increase fish production and minimize the impacts of water infrastructures development.

Workshop on Water Resources Management to Secure Aquatic Biodiversity for Sustainable Development organized on 5 October 2020 in Palembang, Indonesia

1.3 Compilation of scientific data and information to support policy formulation and management of sustainable fisheries

Harmonization and Enhancing the Utilization of Fishery Statistics and Information

As is widely recognized, fishery statistics and information are essential for policy planning and management of fisheries toward sustainability, and along the line of such concern, SEAFDEC has been undertaking initiatives in compiling fishery statistics from the countries bordering the South China Sea Area since 1978. Considering that harmonization of data is important to facilitate the exchange and compilation of statistics at various levels, *i.e.* national, regional and international levels; SEAFDEC therefore developed the "Regional Framework for Fishery Statistics of Southeast Asia" that include the "standard definitions and classifications" that match with the international standards, and the "area of coverage" and "statistical usage" consistent with those of SEAFDEC. The Regional Framework has since then been used for compiling the fishery statistics provided by the Southeast Asian countries to SEAFDEC since 2008. Nonetheless, the recent developments that continue to take place, especially with respect to new standards established by the Coordinating Working Party (CWP) on Fishery Statistics, call for further harmonization of the Regional Framework. The project **"Harmonization and Enhancing the Utilization of Fishery Statistics and Information"** was therefore implemented by the SEAFDEC Secretariat, covering the period from 2020 to 2024 with the goal of facilitating the revision of the Regional

Framework for Fishery Statistics of Southeast Asia to accommodate the newly developed global standards and enhance the utilization of fishery statistics data and information for policy planning and management of fisheries toward sustainability.

In 2020, SEAFDEC continued to coordinate with the AMSs and relevant organizations to support the submission of national statistics for regional/international compilation. In order to share the views and experiences on data compilation, and the situation on fishery statistics of the countries in the region, a representative from the SEAFDEC Secretariat attended in "the Twenty-eighth Session of Asia and Pacific Commission on Agricultural Statistics" organized by FAO on 10–14 February 2020 in Bali, Indonesia. As reported during the aforementioned Meeting, the SEAFDEC project's workplan includes a revision of the Regional Framework for Fishery Statistics of Southeast Asia which was supposed to be accomplished during the proposed First Regional Technical Consultation in 2020. Aimed at gathering inputs from the AMSs for the revision of the Regional Framework, the Consultation however could not be organized in 2020 because of the COVID-19 pandemic. Nevertheless, this was proposed to be organized in 2021.

Twenty-eighth Session of the Asia and Pacific Commission on Agricultural Statistics (10–14 February 2020, Bali, Indonesia)

Another component of this project is the preparation of the publication "Southeast Asian State of Fisheries and Aquaculture" or SEASOFIA 2022, to be published by the SEAFDEC Secretariat in collaboration with the SEAFDEC Departments, for dissemination in 2022. SEASOFIA was first published in 2012 for stakeholders to make full use of the region's fishery statistics, other data and information including those that could be derived from the SEAFDEC programs and projects, and enable them to obtain better understanding of the status of the fisheries sector of the region. Adhering to the request of the SEAFDEC Council to consider sustaining this initiative and producing the publication every five years, the second SEASOFIA was therefore produced in 2017. Preparations are now underway for the publication of the upcoming SEASOFIA 2022. In this regard, the SEAFDEC Secretariat convened the "First Inter-Departmental Consultation on Preparation of SEASOFIA 2022" on 6–7 August 2020 through an online platform. Attended by officials of the SEAFDEC Secretariat and Departments, the Consultation discussed and agreed on the draft outline, required inputs, preparation process, and workplan of the publication. Furthermore, the focal persons of each SEAFDEC Departments were also identified. Subsequently, the "Second Inter-Departmental Consultation on Preparation of SEASOFIA 2022" was organized on 1 October 2020 to finalize the outline and scope of topics to be prepared by

the respective Departments as their inputs for the publication. In addition, the SEAFDEC Secretariat prepared a set of questionnaires to gather additional national inputs from the respective AMSs on particular subject matters that would strengthen and widen the coverage of SEASOFIA 2022.

First Inter-Departmental Consultation on Preparation of SEASOFIA 2022 (6–7 August 2020, online meeting)

SEAFDEC Secretariat and TD staff attending the Second Inter-Departmental Consultation on Preparation of SEASOFIA 2022 (1 October 2020, online meeting)

It should also be noted that this Project serves as a platform to disseminate the outputs, outcomes and results of the various projects implemented by SEAFDEC. In 2020 for example, three issues of the Special Publication "Fish for the People" were published and disseminated to target audiences. Meanwhile, another regular publication of the SEAFDEC Secretariat, the "Fishery Statistical Bulletin of Southeast Asia 2018" that include a compilation of the fishery statistics and other relevant information and data from the respective AMSs in line with the harmonized Statistics Frameworks, was also published and disseminated.

The Fishery Statistical Bulletin of Southeast Asia 2018, and three issues of the Special Publication "Fish for the People" *published in 2020*

1.4 Development and promotion of regional measures and tools for combating IUU fishing

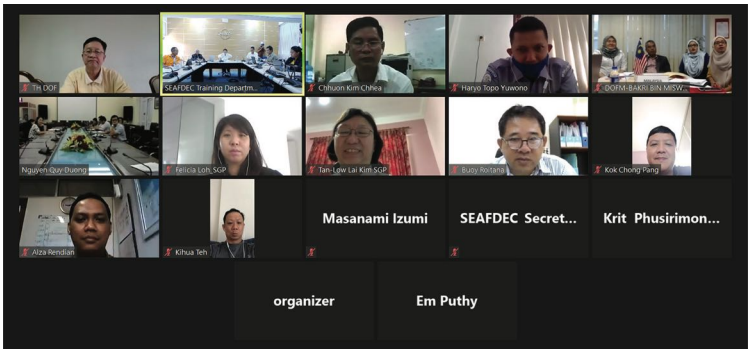
Strengthening Regional Cooperation and Enhancing National Capacities to Eliminate IUU Fishing in Southeast Asia

In order to address concerns on illegal, unreported and unregulated (IUU) fishing in the Southeast Asian region, SEAFDEC has implemented a number of programs and projects to develop regional frameworks and tools to support the actions of the AMSs in combating IUU fishing. In sustaining such efforts, TD launched its new 5-year project in 2020 **"Strengthening Regional Cooperation and Enhancing National Capacities to Eliminate IUU Fishing in Southeast Asia."** With the overall objective of achieving "sustainable utilization and sound management of the fishery resources of Southeast Asia," the Project has four components, namely: 1) Enhancing the Regional Fishing Vessels Record (RFVR) Database; 2) Strengthening national capacities in the implementation of Port State Measures (PSM) and Monitoring Control and Surveillance (MCS); 3) Advancing the promotion of the electronic ASEAN Catch Documentation Scheme (eACDS); and 4) Coordinating and promoting a national/ regional/international network for collaborative activities to combat IUU fishing.

In 2020, TD organized the "Teleseminar on the Way Forward for Combating IUU Fishing in Southeast Asia" from 24 to 26 August 2020 through an online platform. The Teleseminar was attended by 578 participants including representatives from the AMSs. The panelists of the Seminar were representatives from the partner organizations of SEAFDEC, including the Food and Agriculture Organization of the United Nations (FAO), the DG for Maritime Affairs and Fisheries (DG MARE) of the European Union, Sustainable Fisheries Research and Development Foundation, the RPOA-IUU Secretariat, OceanMind, International Monitoring Control and Surveillance (IMCS) Network, and the US National Oceanic and Atmospheric Administration (NOAA). During the Teleseminar, the panelists provided the updated information and progress of activities undertaken by their respective organizations toward combating IUU fishing with particular emphasis in the Southeast Asian region. From the presentations and discussions, the fundamental elements that are required for effective means of combating of IUU fishing were identified, such as strong political will and commitment, cooperation and collaboration, transparency, law enforcement, capacity development, technologies and innovations, and sustainability of the initiatives and mechanisms. The ways forward and the national and regional levels were also determined.

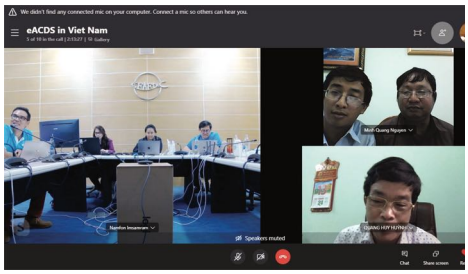
Teleseminar on Way Forward for Combating IUU Fishing in Southeast Asia organized via Zoom from 24 to 26 August 2020: the project team facilitating the Teleseminar at TD (left)*, and resource persons of the Teleseminar* (above)

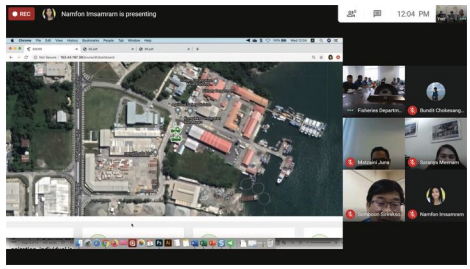
Subsequently, back-to-back with the Teleseminar, TD also organized the "Teleworkshop on the Development and Improvement of Regional Tools for Combating IUU Fishing in Southeast Asia" from 27 to 28 August 2020, also through an online platform. A total of 49 participants comprising the representatives from the AMSs responsible for combating IUU fishing activities at policy-making level, SEAFDEC's National RFVR Focal Points, and fishery officers from the AMSs responsible for national PSM and port control/inspection participated in the Teleworkshop. Discussed during the Teleworkshop were the activities of SEAFDEC in combating IUU fishing, *i.e.* the RFVR and implementation of PSM, and the ways forward for updating the RFVR Database for vessels 24 meters in length and over, including the development of a platform to enable countries to update their respective data and information, development of the dashboard to generate summary information from the RFVR Database, and linkages between the RFVR Database and the FAO Global Record of Fishing Vessels, Refrigerated Transport Vessels and Supply Vessels (Global Record). On the proposed RFVR Database for vessels less than 24 meters in length, the participants agreed technically that vessels within the range of 18.00–23.99 meter in length should be suitable for inclusion in such Database. Furthermore, the needs and actions for the effective and efficient implementation of PSM in the ASEAN were also identified, including the capacity building and sharing of information among the AMSs on PSM implementation, which should be enhanced.

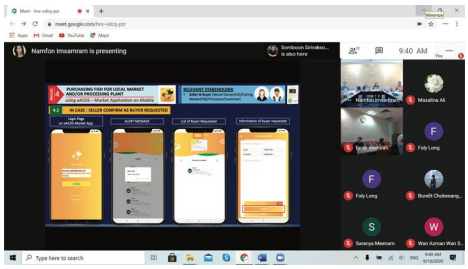


Participants of the Teleworkshop on Development and Improvement of Regional Tools for Combating IUU fishing in Southeast Asia from 27 to 28 August 2020 through Zoom

With regards to the eACDS, TD conducted a series of training on the use of eACDS application (version 2) focusing on the Catch Declaration (CD) and Movement Document (MD), *i.e.* for Viet Nam on 13–14 August 2020, for Brunei Darussalam on 2–3 September 2020, and for Malaysia on 10–11 September 2020. Nevertheless, all these training sessions had to be conducted through online platform due to the COVID-19 situation. After the online trainings, the participating countries continued with the process to test the eACDS application for CD and MD in close communication with the eACDS Team from SEAFDEC. For the other 2 parts of the application, *i.e.* Statement of Catch (SC) and Catch Certification (CC), another training sessions would be organized in 2021 after the trial of the first part is completed.







On-line training on the use of eACDS application version 2 for Viet Nam, Brunei Darussalam, and Malaysia (clockwise)

In 2020, TD also promoted the application of the eACDS to Cambodia with the conduct of the "Introductory Workshop on eACDS" for the Fisheries Administration (FiA) and relevant agencies in Phnom Penh, Cambodia on 18 February 2020. Discussion was made on the possibility of implementing eACDS in Cambodia with particular focus on small-scale fisheries.

1.5 Promotion of innovative management tools and concepts applicable for the region

Small-scale Fisheries Management for Better Livelihood and Fisheries Resources

In the past years, SEAFDEC has been promoting the implementation of the concept on Ecosystem Approach to Fisheries Management (I-EAFM) in the AMSs through human resource development and pilot implementation at selected project sites. In 2020, the initiative has been sustained by TD through its new project **"Small-scale Fisheries Management for Better Livelihood and Fisheries Resources."** To be implemented from 2020 to 2024, the Project aims toward sustainable management of small-scale fisheries for improving the livelihood and well-being of fishers in Southeast Asia, and includes strengthening of human resource development and promoting the implementation of the EAFM in pilot countries. The lessons learnt from the Project implementation would be shared and used for the development of recommendations on the effective implementation of the EAFM in the region.

Specifically, this Project will provide capability development to improve livelihood and well-being of small-scale fishers in support of the implementation of the FAO Voluntary Guidelines for Securing Sustainable Small-scale Fisheries in the Context of Food Security and Poverty Eradication (SSF Guidelines). Furthermore, the Project would also support the conduct of study on the status of fishery socio-economic assistance and on gender assessment. The regional cooperation in fishery socio-economic development and approach/process would

be strengthened in conjunction with the action plans for supporting the livelihood and well-being of small-scale fishers in Southeast Asia. Meanwhile, gender integration and empowerment in sustainable fisheries management, which include fisheries processing and the value chain will be promoted through the regional and national training courses and human resource development programs. Although Tonle Sap (in Cambodia) and Ranong– Kawthoung (in Thailand–Myanmar) were selected as learning sites for this project, the activities in 2020 had to be adjusted due to the COVID-19 pandemic situation. For the learning site in Tonle Sap, only online discussion could be carried out; while for the learning site at Ban Hat Sai Khao in Suk Samran District, Ranong Province, a number of onsite activities could be conducted by TD.

Specifically, TD organized the "Training Course on Essential Ecosystem Approach to Fisheries Management (E-EAFM)" on 14–18 September 2020 in Ranong Province, which was aimed at introducing the EAFM process to the fishery officers and key fishery stakeholders in Ranong Province, and strengthening their capacity to implement the EAFM concept. The 16 participants included officers from the Ranong Provincial Fisheries Office and Ranong Marine Fisheries Research and Development Station, as well as community members of Ban Hat Sai Khao. Subsequently, TD conducted the "Workshop on Development of the EAFM Plan for Ranong Province Learning Site" on 25–26 November 2020 to discuss among the key stakeholders and define the specific fisheries management area, identify the key stakeholders and conduct a problem analysis, to be used as basis for the development of the EAFM plan for the community in Ban Hat Sai Khao.

Training course on Essential Ecosystem Approach to Fisheries Management (E-EAFM) from 14–18 September 2020 in Ranong Province, Thailand

Workshop on Development of the EAFM Plan for Ranong Province Learning Site from 25 to 26 November 2020 in Ranong Province, Thailand

To come up with the baseline information on demography and socio-economic condition of the people as well as the needs for the EAFM plan development in the pilot learning site in Ranong Province, data collection on the status of fishery socio-economic assistance was conducted from 5 to 11 October 2020. A total of 42 respondents (30 male and 12 female) comprising the small-scale fishers at Ban Hat Sai Khao, as well as boat owners who are engaged in fisheries activities, were interviewed to obtain the necessary baseline data and information. Data validation workshop was then organized on 10 October 2020 to present the results of the survey to the community members and obtain their feedback. It is expected that the results of the survey would be further used for monitoring and evaluation which will be carried out during and after the project implementation.

Data collection on fishery socio-economic status in the pilot learning site in Ranong Province

Data validation workshop to present the results of the survey to community members

With regards to gender-related activities, a preliminary survey on gender integration in fisheries was conducted by the staff of TD in coordination with the DOF Thailand at Ban Subsomboon, Buri Ram Province, Thailand from 4 to 6 December 2020. The aim of the survey was to promote gender in fisheries to support gender equality in the whole society. The preliminary survey came up with the basic information on the aquatic animal food bank in Subsomboon Group, which comprises a strong group of women in the community.

Preliminary survey on gender integration in fisheries in Ban Subsomboon, Buri Ram Province, Thailand

1.6 Development and promotion of responsible fishing technologies

Responsible Fishing Technology and Practice

For over two decades, TD has continued its programs of activities on development and promotion of environmental-friendly fishing gears and practices with a view to enhancing the sustainable utilization of marine and coastal fishery resources, minimizing the adverse impacts of fishing on the ecosystems and environment, and securing fish supply for food security and livelihood of peoples in the Southeast Asian region. In 2020, TD therefore continued to sustain such efforts through its new regional project **"Responsible Fishing Technology and Practice,"** which would be carried out from 2020 to 2024. Besides the development/promotion of environment-friendly fishing gears and practices, this Project would also promote the Low Impact and Fuel Efficient (LIFE) fishing, applying appropriate fishery machinery onboard fishing vessels, improving onboard fish handling practices, and addressing the issues on Abandoned, Lost or Otherwise Discarded Fishing Gear (ALDFG). It is expected that such technological improvements through the Project would result in changes of the behavior and practices of fishers to be more responsible by reducing the negative impacts of fishing on the aquatic ecosystems, lowering carbon emissions and

lessening fuel costs, and utilizing the fishery resources more economically and sustainably for improved human well-being and livelihoods of fisherfolks in the Southeast Asian region.

Online Regional Technical Meeting on Reducing Negative Impacts of Fishing to the Ecosystem, Optimizing Energy and Fuel Consumption, and Enhancing Safety in Fishing Practices in Southeast Asia conducted on 21 and 28 September 2020

To kick-off the Project activities, TD conducted the "Regional Technical Meeting on Reducing the Negative Impacts of Fishing to the Ecosystem, Optimizing Energy and Fuel Consumption, and Enhancing Safety in Fishing Practices in Southeast Asia" on 21 and 28 September 2020 through an online platform. The Meeting was attended by international resource persons from the FAO and the National Research Institute of Fisheries Engineering (NRIFE) of Japan, and participants from the SEAFDEC Member Countries. Through this Meeting, the participants acquired additional experience and knowledge on the global fisheries situation and issues, *i.e.* bycatch, discards, marine debris from ALDFG, ghost fishing, impacts of fishing on biodiversity and ecosystem; the world status of safety at sea for fishing practices; and innovative technologies and energy efficiency. Through questionnaires and discussions during the Meeting, the participants identified the issues and challenges relevant to the impacts of fishing gears and practices to the environment, potential fishing gear modification/trials to reduce and mitigate their impacts on the ecosystem, and the potential marine engineering techniques to improve fuel utilization and safety in fishing operations in the Southeast Asian region. With regards to fisheries engineering, human resource development (HRD) programs on energy saving and optimizing energy were suggested. The need for training for trainers and information dissemination/sharing, *i.e.* a simplified pamphlet translated into local language for local fishers, were also raised.

In 2020, the project also addressed the issue on ALDFG which is one of the significant components of marine litters that created serious impacts on the habitats, fish stocks, and other marine species. Ghost fishing as a result from ALDFG removes both target and non-target species, including seabirds, sea turtles, marine mammals, and elasmobranchs, some of which are endangered, threatened and protected (ETP) species. As preliminary

step to address the issue, TD conducted a number of investigation surveys to estimate the abandoned, lost, and discarded traps and gillnets along the coasts of Thailand, both in the Gulf of Thailand and the Andaman Sea during 31 October–5 November 2020, 12–16 November 2020, 24 November–7 December, and 15–18 December 2020. The objectives of these surveys were to estimate the quantity of gillnets and traps lost, and the economic losses caused by the loss of these fishing gears in small-scale fisheries. The surveys came up with feedbacks from the questionnaire on fishing gear lost and the report based on the information collected from the surveys.

Preliminary investigation surveys to estimate the abandoned, lost, and discarded traps and gillnets along the coastal areas of Thailand

Another on-going work of TD is the development and promotion of onboard fish handling techniques to maintain the quality and freshness of the catch. For 2020, TD conducted the "Regional Training of Trainers (TOT) on Fish Handling Techniques Onboard Fishing Vessels" on 3–7 August 2020. Conducted through an online platform and attended by 8 participants from the AMSs, the training course had enhanced the participants' knowledge and experiences on improvement of fish handling techniques, reduction of post-harvest losses, and hygiene and good practice of fish handling onboard. The participants also provided updated information on the current situation and problems relevant to fish handling in their respective countries.

Regional Training of Trainers (TOT) on Fish Handling Techniques Onboard Fishing Vessels, conducted through an online platform on 3–7 August 2020

Through this Project, TD had acquired in 2020, a new medium-sized vessel, the M.V. PLALUNG, a multipurpose coastal training and research vessel that can accommodate a number of crew members and researchers onboard. The new M.V. PLALUNG would be improved in 2021 to enhance its energy efficiency, performance, etc. Furthermore, a new scientific echosounder SIMRAD EK-80 was also acquired through this Project, and the equipment would be installed in the M.V. SEAFDEC 2 in 2021. It is expected that this would enhance the capacity of the M.V. SEAFDEC 2 to support the Member Countries in conducting marine environmental and fishery resources surveys in the future.

The new M.V. PLALUNG acquired by TD to serve as a multipurpose coastal training and research vessel

Improvement of Fisheries Technology and Reduction of the Impact from Fishing Activities

In addition to the aforementioned regional project, SEAFDEC/TD also implemented its Departmental Program **"Improvement of Fisheries Technology and Reduction of the Impact from Fishing Activities."** In 2020, the activities undertaken by TD include: 1) research on marking of fishing gear; 2) study on the midwater trawl net construction and design suitable for the M.V. SEAFDEC 2; and 3) study on the scientific echo sounder suitable for the M.V. SEAFDEC 2.

TD also provided technical support to the DOF of Thailand by building the capacity and knowledge of its 36 fishery officers, on the model structure and construction of commercial fishing gears through the Workshop organized from 3 to 7 August 2020. The lecture topics included structures, materials, and construction of bottom trawl net, purse seine net, and anchovy falling net, while the practical sessions focused on model construction and repair of fishing gears.

Workshop on Model Construction and Structure of Commercial Fishing Gear for Officers from the DOF of Thailand (Samut Prakan, 3–7 August 2020)

1.7 Integration of habitat and fisheries management and provision of support for the conservation of important fishery resources

Establishment and Operation of a Regional System of Fisheries* Refugia *in the Southeast China Sea and Gulf of Thailand

After the "Regional Guidelines for Responsible Fisheries in Southeast Asia" with supplementary guidelines on fisheries *refugia* was published in 2006, the fisheries *refugia* approach has triggered common interest in the Southeast Asian region as good area-based management practice that integrates several tools to achieve sustainable

fisheries and conservation of critical habitats. To promote the application of fisheries *refugia* approach, the Project **"Establishment and Operation of a Regional System of Fisheries *Refugia* in the South China Sea and Gulf of Thailand"** was launched in 2016 to integrate habitat and biodiversity conservation considerations into fisheries management and practices. Implemented by the United Nations Environment Programme (UNEP) with support from the Global Environment Facility (GEF), the Project was executed regionally by SEAFDEC/TD in partnership with the government agencies responsible for fisheries of six participating countries, namely: Cambodia, Indonesia, Malaysia, Philippines, Thailand, and Viet Nam, Specifically, the Project which aims to promote the fisheries *refugia* approach for safeguarding the habitats critical to the life cycles of important fishery resources as this would not only improve and secure marine biodiversity but also build resilience for those who rely on the oceans for their food and livelihoods, has four components: 1) Identification and management of fisheries and critical habitat linkages at priority fisheries *refugia* in the South China Sea; 2) Improving the management of critical habitats for fish stocks of transboundary significance *via* national and regional actions to strengthen the enabling environment and knowledge-base for fisheries *refugia* management in the South China Sea; 3) Information management and dissemination in support of national and regional-level implementation of the fisheries *refugia* concept in the South China Sea; and 4) National cooperation and coordination for integrated fish stock and critical habitat management in the South China Sea.

While four participating countries, namely: Cambodia, Malaysia, Philippines, and Thailand, had made significant progress in the implementation of their respective national activities during the past years, some countries like Viet Nam and Indonesia encountered some difficulties that led to delays in signing of their Letters of Agreement (LOAs) and after the concerns were addressed, their respective LOAs were finally signed only in 2019. Nevertheless, several activities planned for 2020 could not be undertaken due to the COVID-19 pandemic and had to be postponed. This necessitated the extension of the project period, which was originally scheduled to be completed by the end of 2020, until mid of 2023. Nonetheless, the progress of the project implementation as of 2020 could be summarized as follows:

Component 1: Identification and management of fisheries and critical habitat linkages at priority fisheries *refugia* in the South China Sea

- Letters of Agreement signed by all participating countries
- Fisheries and coastal habitat information and data collection programs for 15 priority fisheries *refugia* sites initiated
- Intensive series of consultations on the boundaries of fisheries *refugia* organized and supported by facilitating the processes to identify key threats to fisheries *refugia* sites and initiate discussions about possible management measures for evaluation
- Governance reviews, stakeholder analysis, socio-economic information and data collation, and reviews of existing management arrangements started and are in progress in 12/15 sites
- National teams trained in project management and governance arrangements
- 12 of the 15 identified fisheries *refugia* sites in Cambodia, Indonesia, Malaysia, Philippines, and Thailand confirmed, including:
    - Two *refugia* adopted by the Government of Cambodia: in Kep Province (417 ha) for blue swimming crab and Koh Kong Province (1,283 ha) for short mackerel

- Preparations for the proposed demarcation *refugia* areas in Thailand and Malaysia carried out, based on scientific findings for finalization with relevant stakeholders at the site level; where the two proposed demarcation *refugia* areas in Malaysia are approximately 140,023 ha, while the two proposed *refugia* areas of Thailand would cover 140,000 ha.

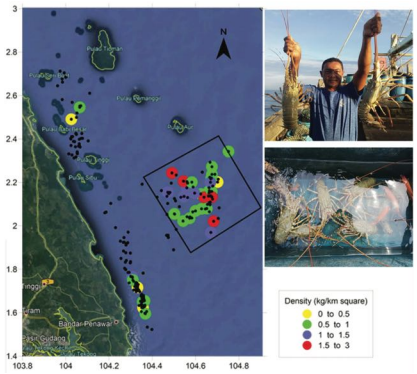
Component 2: Improving the management of critical habitats for fish stocks of transboundary significance *via* national and regional actions to strengthen the enabling environment and knowledge-based for fisheries *refugia* management in the South China Sea

- Working document for regional level review on key threats from fishing and the environment to fish stock and critical habitat linkages at the priority sites in the participating countries, developed
- Existing regulations and by-laws in the areas of the 12/15 sites at which the project is presently working, compiled and reviewed with feedback provided to national teams, to aid in the formulation of recommendations on policy and legal reforms to support promotion of responsible fishing at times and at locations critical to fish stock and critical habitat linkages
- Workshops with local stakeholders and officials on policy and legal aspects of *refugia* (terminology, procedures, recommended reforms) in the participating countries organized and served as fora for discussions to be viewed through a more realistic lens which reflects local stakeholder needs, expectations, and concerns about socio-economic impacts of management
- Questionnaire survey templates prepared to: (a) compile and update information and data on the distribution of habitats, known spawning areas, locations of *refugia*, MPAs, fisheries management areas, and critical habitats for endangered species; and (b) produce detailed site characterizations for the 15 priority fisheries *refugia* sites for incorporation into national and regional datasets, where the detailed Terms of Reference for the development and application of a modelling system linking oceanographic, biochemical, and fish early life history information to improve regional understanding of fish early life history and links to critical habitats have been prepared and discussed with regional universities, and internationally recognized institutions with expertise in this field.
- National Review and Recommendations for Reform of Regulation/Ordinance carried out:
  - In Cambodia, new law on fisheries that included and classified marine fisheries *refugia* as a fisheries management area, would be promulgated and published by 2021 for wider use at national and provincial level
  - In the Philippines, national, provincial and municipal regulations/ordinances for responsible fishing practices at priority *refugia* reviewed *via* the EAMF workshop in three *refugia* sites
  - In Thailand, Department of Fisheries endorsed the Regulation and Fisheries Management for Fisheries *Refugia* in Thailand, which was published in November 2020, and includes reforming of laws, regulations and fisheries management, and the legislative process on fisheries *refugia* in Thailand
- National policies endorsed:
  - In Cambodia: the Proclamation of the Establishment of Management Area of Mackerel Fisheries *Refugia* in Koh Kong, and the Blue Swimming Crab Fisheries

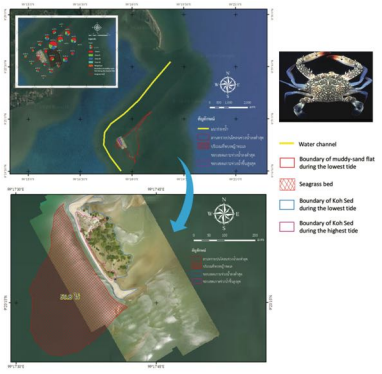
Refugia in Kep was endorsed by the Minister of Ministry of Agriculture, Forestry, and Fisheries (MAFF) in 2019
    - In Cambodia, the national program on establishment of Fisheries *Refugia* for blood cockles in Sihanoukville Province extended, and Government endorsed the Proclamation of this Fisheries *Refugia* in 2020
- National Guidelines on Establishment and Management of Fisheries *Refugia* developed:
    - In Cambodia and Philippines, the national Guidelines developed through Stakeholders Consultation Meetings
- National Management Plan drafted:
    - In Cambodia, a working group was set up to draft their national work plan and national framework aligned with the regional framework to improve the fisheries policies and laws, as well as support long term management of Indo-Pacific mackerel in their waters (Note: The same process will be followed in the other countries once the *refugia* are established through engagement of multi-stakeholders)
- National Action Plan for Management of Fisheries *Refugia* developed:
    - In Cambodia, the Marine Fisheries Management Area (MFMA) Management Plan for the Blue swimming crab Fisheries *Refugia* in Kep Province, was endorsed; and drafting the MFMA Management Plan for Short Mackerel in Koh Kong Province, in progress
- Regional Policy and Guidelines established:
    - On improved management policy of critical habitats for fish stocks of transboundary significance, the Regional Action Plan (RAP) for Management of Short Mackerel (Indo-pacific Mackerel) in the Gulf of Thailand Sub-region where the results is extended to the South China Sea Sub-region was drafted in September 2019 and adopted by the SEAFDEC Council in May 2020, and the RAP-Short Mackerel was submitted to the 23FCG/ASSP in November 2020 and endorsed to the ASWGFi in 2021 for further support and endorsement under the ASEAN Policy Framework
    - The Regional Guidelines for Management of the Fisheries *Refugia* drafted in September 2019, includes the key steps on Establishment of Fisheries *Refugia*, the standardized methods for collection and analysis, as indicators
- Ocean modelling system based on the existing system developed under the IOC/WESTPAC and could be accessed through the following URL: http://221.215.61.118:2018/#/

Stakeholders consultation meeting on preparation for action plan for mackerel refugia *management in Koh Kong Province (27-28 October 2020)*

Discussion with fishers' community in Mapur Village in cooperation with the Fisheries Agency of Province of Bangka Belitung Islands, Indonesia (5 November 2020)



*Fisheries Resources Survey on Mud Spiny Lobster (*Panulirus polyphagus*) in East Johor-South Pahang Waters, Malaysia.*



Boundary Delineation and Management Planning of Fisheries Refugia *for Blue Swimming Crab in Koh Sed, Ban Don Bay of Surat Thani Province, Thailand*

Quarterly Meeting of Refugia *Site Management Committee in Pangasinan, Philippines (6 February 2020)*

Component 3: Information Management and Dissemination in support of national and regional-level implementation of the fisheries *refugia* concept in the South China Sea

- The "fisheries-refugia.org" regional web site developed and populated with newly developed short films, journal articles written by regional project staff during the reporting period and supported by various social media platforms including YouTube and Facebook, while a six-part short film social media campaign has been prepared for dissemination
- In 2020, about 140 publications from national and regional programs uploaded into the SEAFDEC repository system which is linked to the Fisheries *Refugia* Website (http://repository.seafdec.or.th/handle/20.500.12067/861)
- Information Management and Dissemination at national level carried out where the establishment of the learning center for the promotion of Fisheries *Refugia* is one of the key outputs:
  - In Malaysia, two learning centers set up at the *refugia* sites in cooperation with private sector and the state government, while more centers would be set up in other areas
  - In the Philippines, two centers planned to be set up in early 2020 at Bolinao and Masinloc sites with the support from the Municipal Government

- Awareness Building Programs promoted:
  - In Malaysia, awareness-raising materials were prepared and set up at the learning centers in Miri, Sarawak, and Tanjung Leman in Johor while video documentations were developed, and resources awareness program conducted at Kuala Baram in Miri in 2018
- Outreach Programs organized:
  - In Malaysia, the DOF Malaysia in collaboration with Radio Televisyen Malaysia (RTM) produced a 30 minutes documentary about the lobster *refugia* program at East Johor-South Pahang and aired in the Simfoni Alam program on the 25 December 2018, while for tiger prawns, the documentary Khazanah Udang Harimau Negara was aired in the Simfoni Alam slot on 4 December 2018, and another two learning centers being established in the two *refugia* sites to promote fisheries *refugia*
  - In Malaysia, while establishment of the learning centers at *Refugia* Sites are in progress, IEC materials such as leaflets and RA 10654 booklets distributed to schools

Component 4: National cooperation and coordination for integrated fish stock and critical habitat management in the South China Sea

- Third Meeting of Regional Scientific and Technical Committee (RSTC3) was organized in February 2020 to create the regional cooperation in the integration of scientific knowledge and research outputs with management, discuss the management of transboundary species and other management tools to support the establishment of fisheries *refugia* by the countries, and update on the progress works at the national and regional levels
- Third Project Steering Committee Ad-hoc Meeting (PSC3 Ad-hoc) was organized on 16 June 2020 as a virtual meeting hosted by the SEAFDEC/PCU, the outputs included the adopted proposed two-year project extension for 2021 and 2022, which was deemed necessary because the project achievements are less than 50 % while the budget spent on implementation is less than 50 %; Indonesia and Viet Nam signed the LOA/LOI in mid-2019; and the COVID-19 impacts on the activities planned from March until end of 2020 while it is still unpredictable how the COVID-19 continues to affect the implementation; nonetheless, the participating countries agreed to reduce 10 % of their unspent budget as of 30 December 2019 to support the project extension
- Fourth Project Steering Committee Ad-hoc Meeting (PSC4 Ad-hoc) was organized on 6 October 2020 as a virtual meeting hosted by the SEAFDEC/PCU, to finalize and endorse the proposed budget revision and the cost-Workplan for two-year extension period from 2021 to 2022 from participating countries and the SEAFDEC/PCU, which would be submitted to the UNEP for consideration and approval
- Fourth Regional Scientific and Technical Committee Meeting (RSTC4-virtual meeting) scheduled for December 2020 was postponed to the 1st Quarter of 2021, while the mid-term evaluator will be invited to the meeting

Conservation and management of sharks and rays

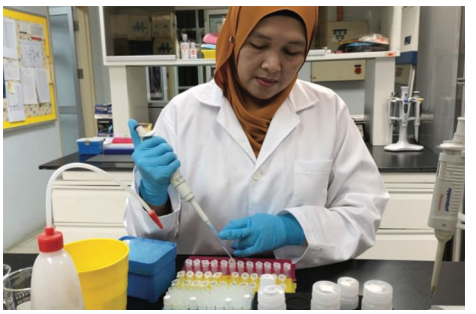
Sharks and rays have been among the most important subjects of discussion during the several sessions of the Conference of the Parties (CoPs) to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) including the recent CoP-18 CITES in August 2019 in Geneva, Switzerland. While several species of sharks and rays had been listed in the CITES appendices during the last decade, it is still possible that more

species of sharks and rays could be proposed for listing in the CITES Appendices in the future. Although the species already listed in the Appendices of CITES could still be exported including their products, exporting countries should first carry out a study to establish the Non-Detrimental Findings (NDFs) for such species. To fulfil the requirements for NDFs and other management purposes, exporting countries should collect landing, biological, socio-economic, and trade data of the species and prepare specific management plans for their conservation and sustainable utilization. To enable the AMSs to accommodate such requirements, it is necessary that their expertise on species identification and collection of data on landings and biology of sharks should be strengthened. Besides, information on the utilization of such species is also useful to enhance the understanding on the socio-economic importance of the species.

In 2020, MFRDMD started its five-year Project **"Research for Enhancement of Sustainable Utilization and Management of Sharks and Rays in the Southeast Asian Region"** which will run until 2024. The objectives of the Project are: i) developing capacity in taxonomy including identification of new species/record and management of major shark species; ii) confirming the stock structures for at least two common species of sharks/rays and one CITES-listed species in participating countries (shared-stock or individual stocks); and iii) carrying out socio-economic studies in Northern Vietnam, Western Myanmar, and Indonesia.

As for the population genetic study of sharks and rays, DNA tissues of *Carcharhinus sorrah*, *Chiloscyllium hasseltii* and *Sphyrna lewini* were collected from the East Coast of Peninsular Malaysia (ECPM) in 2020. A total of 37 specimens of *C. sorrah* and 35 specimens of *C. hasseltii* were collected from Kuantan, Pahang, while DNA tissues of *S. lewini* were collected from Kuala Terengganu (18 specimens), Dungun and Rompin (one specimen from each site), and Kuantan (21 specimens). The specimens are stored in the DNA Laboratory of MFRDMD for analysis.

Specimen collection at Kuantan Port, Pahang



Primers optimization for genetic study

MFRDMD also organized the "First Core Experts Meeting on Research for Enhancement of Sustainable Utilization and Management of Sharks and Rays in the Southeast Asian Region" on 25 November 2020 *via* an online platform. The Meeting was attended by representatives from Cambodia, Indonesia, Japan, Malaysia, Myanmar, Philippines, and Thailand, as well as some officers from the SEAFDEC Secretariat, TD and MFRDMD. With the objective of introducing the new activities under the new Project, and reporting the achievement of the data collection activities carried out by MFRDMD under the previous project on sharks and rays in 2015–2019, the Meeting also discussed the need to develop human capacity for

managing resources of sharks and rays in the region, to publish a field guide for sharks and rays in national languages, and to work for the possibility of downlisting some CITES-listed shark and ray species based on scientific evidence and the established NDFs.

The First Core Experts Meeting on Research for Enhancement of Sustainable Utilization and Management of Sharks and Rays in the Southeast Asian Region, organized on 25 November 2020 through an online platform: (above) *participants from MFRDMD and* (left) *participants from the other SEAFDEC Departments and AMSs*

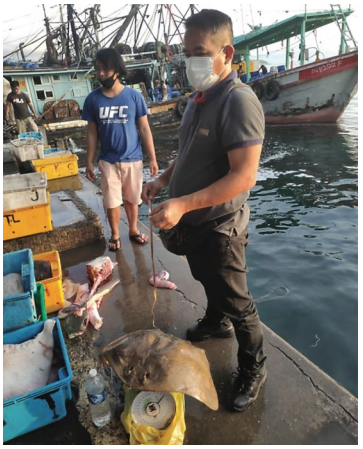
Meanwhile, collection of landing data on sharks and rays was carried out in Kota Kinabalu; Tawau (in Sabah); and Larut Matang (in Perak). However, data could not be collected from Kota Kinabalu in April, May, October, and November 2020 due to the movement control order during the COVID-19 pandemic. This site is crucial considering that shark and ray landings contributed about 0.3 % and 0.9 %, respectively, from the area's total marine landings. Nonetheless, 18 shark species from nine families and 24 ray species from seven families had been recorded so far, where the five most recorded shark species were *Chiloscyllium punctatum*, *C. plagiosum*, *Atelomycterus marmoratus*, *Sphyrna lewini*, and *Carcharhinus sorrah*; and the ray species were *Neotrygon orientalis*, *Telatrygon zugei*, *Maculabatis gerrardi*, *Brevitrygon heterura*, and *Rhynchobatus australiae*.

For Tawau, the landings of sharks and rays contribute about 0.2 % and 2.2 %, respectively, from total the area's total marine landings. Although collection of landing data could not be carried out in April, May, and October 2020 due to the COVID-19 situation, a total of three shark species from two families and ten ray species from five families had been recorded so far. The shark species were *Carcharhinus brevipinna*, *C. sorrah*, and *Sphyrna lewini*; while the five most recorded ray species were *Maculabatis gerrardi*, *Taeniura lymma*, *Neotrygon orientalis*, *Gymnura zonura*, and *Rhynchobatus australiae*.

In Larut Matang, Perak, collection of landing data was conducted in January, February and March 2020. However, no collection of landing data took place in April and May 2020 due to the COVID-19 pandemic. From June onwards due to resignation of the enumerator, the collection of landing data could not be continued. The recorded shark and ray landings

contributed about 0.2 % and 0.7 %, respectively, from the area's total marine landings. Six species of sharks from three families, and 13 species of rays from five families, had been recorded. These were *Chiloscyllium hasseltii*, *C. punctatum*, *C. indicum*, *Atelomycterus marmoratus*, *Carcharhinus sorrah*, and *C. leucas* for sharks; and *Neotrygon orientalis*, *Brevitrygon heterura*, *Rhinobatos borneensis*, *Maculabatis gerrardi*, and *Telatrygon zugei* for rays.

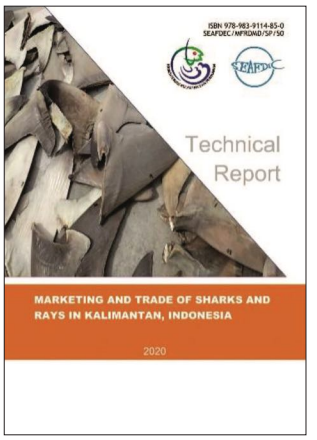
MFRDMD also organized the "Workshop on Landing Data Collection on Sharks and Rays Series 1/2020" on 24–27August 2020. The Workshop aimed to train new enumerators and improve the skills of the participants, especially in managing landings data collected from the designated sites. Two lecturers from Universiti Malaysia Terengganu, and 14 participants including six from the Department of Fisheries Sabah, one research officer from FRI Kg. Acheh, Perak, one contracted staff and six industrial training students, attended the Workshop. Besides lectures on taxonomy and statistics, the participants also learned about the occurrence of parasites in sharks and rays. At the end of the Workshop, the participants were able to identify the common shark and ray species in Malaysia, and manage the data collected from landing sites. The specimens used during the Workshop are being preserved at the MFRDMD Repository in Kuala Terengganu for future reference.



Data collection by the designated enumerator at Kota Kinabalu, Sabah

Practical session during the "Workshop on Landing Data Collection on Sharks and Rays Series 1/2020"

Additionally in 2020, MFRDMD published the report from a survey conducted in Kalimantan in 2019 entitled "Marketing and Trade of Sharks and Rays in Kalimantan, Indonesia." From the survey, it could be concluded that fins, and live sharks and rays were targeted for export to foreign markets, while the shark meat is meant for local consumption in Kalimantan and Java. Most of the fresh meats were processed into smoked and salted meat.



Conservation and management of catadromous eels

Anguillid eels (*Anguilla* spp.) are catadromous aquatic species that live in freshwater and migrate to breed in the ocean. They are one of the most important commercial aquatic species because of their nutritional value and preference as delicacy food especially in the East Asian countries. Since the listing of European eel (*Anguilla anguilla*) in the Appendix II of CITES during its Fourteenth Conference of the Parties in 2007, the demand for other Anguillid eel species has substantially increased, especially for glass eels that are captured in tropical areas including several Southeast Asian countries. This has posed risks for the over-exploitation of tropical anguillid eel species and the possibility of proposing these species for listing in the CITES appendices in the future. Some countries in the region have therefore imposed regulations to avoid overexploitation of the species by regulating the size and prohibiting/limiting the exportation of glass eels. However, relevant information, such as actual catch of anguillid eels in the Southeast Asian countries, eel population structure and its stock status, and biological characteristics, remains minimal to support management toward sustainable utilization of the species.

In order to obtain better understanding of the stock status, biology, and life cycle of tropical anguillid eels in the Southeast Asian region, SEAFDEC during the past years supported the AMSs that have anguillid eel fisheries in the implementation of two projects: 1) Enhancement of Sustainability of Catadromous Eel Resources in Southeast Asia (2015–2019) supported by the Japan–ASEAN Integration Fund (JAIF); and 2) Enhancing the Sustainable Utilization and Management Scheme of Tropical Anguillid Eel Resources in Southeast Asia (2017–2019) supported by the JTF. Through these two projects, activities were undertaken to obtain information of the current situation of anguillid eel resources in the region, develop eel national fishery statistics and data collection systems, and improve the technologies for aquaculture of anguillid eels.

After the completion of these two projects in 2019, SEAFDEC continued its activities on anguillid eels starting in 2020 through two new projects: **"Development of Stock Assessment Methods and Strengthening of Resources Management Measures for Tropical Anguillid Eel in Southeast Asia,"** and **"Sustainable Utilization of Anguillid Eels in the Southeast Asia Region."**

Development of Stock Assessment Methods and Strengthening of Resources Management Measures for Tropical Anguillid Eel in Southeast Asia

The Project "Development of Stock Assessment Methods and Strengthening of Resources Management Measures for Tropical Anguillid Eel in Southeast Asia," being administered by the SEAFDEC Secretariat in close collaboration with IFRDMD, is also supported by the JAIF and covers the duration from 2020 to 2021. It is aimed at collecting catch data and biological/ecological information for the estimation of eel resources/stocks; and developing mathematical/statistical methods for estimating tropical anguillid eel resources stocks in order to formulate effective management measures for the sustainable use of tropical anguillid eels in Southeast Asia. In 2020, SEAFDEC organized the "Project Planning Meeting for the JAIF Project on Development of Stock Assessment Methods and Strengthening of Resources Management Measures for Tropical Anguillid Eel in Southeast Asia" on 3 February 2020 in Bangkok, Thailand with the participation of representatives from the AMSs, namely:

Cambodia, Lao PDR, Indonesia, Malaysia, Myanmar, Philippines, Thailand, and Viet Nam. The Meeting came up with agreement on the activities and workplan for the project.

Participants of the "Project Planning Meeting for the JAIF Project on Development of Stock Assessment Methods and Strengthening of Resources Management Measures for Tropical Anguillid Eel in Southeast Asia" (3 February 2020, Bangkok, Thailand)

For the collection of catch data and biological/ecological information for estimation of eel resources/stocks, the eel catch survey would focus only in Indonesia at three study sites, namely: Cimandiri River and Cikaso River at Palabuhan Ratu, and Poso River at Poso Regency. The data parameters include eel catch, fishing effort, and biological and ecological information for different stages of tropical anguillid eels from glass eel, elvers to yellow eel. In early 2020, however, the planned eel catch survey was suspended due to the domestic travel restrictions in Indonesia. Nonetheless, IFRDMD was able to conduct the surveys at Palabuhan Ratu in August 2020 and at Poso in December 2020, which would be continued in 2021. As for Myanmar, Philippines, and Viet Nam, IFRDMD developed a catch sampling manual to guide the countries' local enumerators to collect the catch data by themselves.

Catch sampling survey in Indonesia

For the development of mathematical/statistical methods for estimating the tropical anguillid eel resources stocks, eel statistical surveys would be conducted in four (4) countries, namely: Indonesia, Myanmar, the Philippines, and Viet Nam. However, due to the COVID-19 situation with travel restrictions across the countries, a series of online meetings were instead conducted in 2020 between the project team and the countries, namely: Myanmar, Philippines, and Viet Nam, to set up the system of collecting data for eel statistics survey. Subsequently, data collection for eel catch statistics started in Viet Nam; while for Indonesia, Myanmar, and the Philippines, the eel statistical surveys would be conducted in 2021.

Moreover, under this Project, IFRDMD also carried out a study on genetic diversity of anguillid eels in the AMSs by collecting DNA tissue samples from *A. bicolor bicolor* and *A. bicolor pacifica* in Indonesia, Myanmar, Philippines, and Viet Nam. Results of this study is described in a forthcoming scientific article "Genetic diversity, population structure and demographic history of the tropical eel *Anguilla bicolor pacifica* in Southeast Asia using mitochondrial DNA control region sequences" in the Global Ecology and Conservation Journal, and authored by the team members from Indonesia, Philippines, and Japan. In 2020, twenty-seven DNA samples were collected from North Maluku in Indonesia and analyzed in the laboratory of IFRDMD, but the tissue samples from the other countries could not yet be collected.

Sustainable Utilization of Anguillid Eels in the Southeast Asia Region

The Project "Sustainable Utilization of Anguillid Eels in the Southeast Asia Region," which is funded by JTF and implemented by IFRDMD, is aimed at promoting sustainable management and utilization of anguillid eel fishery resources in the Southeast Asian region through the development and implementation of the strategic program of sustainable eel resources management. The Project has two scopes of activities that aim to: enhance sustainable eel fishery resources through development/ improvement of the standard data collection system in Southeast Asia; and map the genetic population structure of tropical eels in Southeast Asia based on mtDNA approach.

In 2020, IFRDMD initiated the data collection of eel catch and effort in Indonesia and Philippines. In Indonesia, data collection was carried out during January–March 2020 in four study sites, *i.e.* Bengkulu, Palabuhan Ratu, Cilacap, and Poso, after which the activity was suspended due to limited eel fisheries in the country due to the COVID-19 pandemic. In the Philippines, data collection was carried out only in Cagayan Province from January to September 2020.

IFRDMD also continued to carry out another study on anguillid eel in South Sulawesi in collaboration with the Halu Oleo University in Kendari, South Sulawesi. The "monthly sample and catch data collection of baseline results of adult eel (silver eel) and their biology in Southeast Sulawesi," which started since December 2019 was continued until May 2020. The catch data in December 2019 and January 2020 had been analyzed while the analysis of the biological data such as length–weight relationship and growth condition is still ongoing.

DNA tissue sampling of eels for genetic diversity study

For the promotion of eel biodiversity conservation, IFRDMD carried out a genetic study with the objective of identifying the genetic population structure of the tropical eels (all *Anguilla* spp. except *A. bicolor*) in Southeast Asia using mtDNA D-loop region. In 2020, IFRDMD analyzed 198 samples of *A. marmorata* from Indonesia, consisting of 36 samples from Poso; 35 samples from Palu; 20 samples from Bengkulu; 22 samples from Kendari; 44 samples from Pelabuhan Ratu; and 41 samples from Ternate. IFRDMD also received 150 tissue samples of glass eels from Viet Nam, consisting of 100 samples from Phu Yen and 50 samples from Binh Dinh, which are being morphometrically checked in the laboratory. The samples from the Philippines, which have been collected from Cagayan and Mindanao in early 2020, have not been sent to IFRDMD due to transport/logistical constraints brought about by the COVID-19 pandemic. Moreover, collection of samples could not be undertaken in Myanmar this year due to the COVID-19 pandemic.

Conservation and management of neritic tunas

In 2020, the activities of SEAFDEC on conservation and management of neritic tunas were implemented mainly through the project **"Fisheries Management Strategies for Pelagic Fish Resources in the Southeast Asian Region"** (see 1.1, Sub-topic on Fisheries Management Strategies for Pelagic Fish Resources in the Southeast Asian Region).

The revised Terms of Reference (TOR) of the SWG-Neritic Tunas which was endorsed by the SEAFDEC Council at its Fifty-second Meeting was presented to the "Sixth Meeting of the Scientific Working Group on Neritic Tunas Stock Assessment in the Southeast Asian Waters." Under the revised TOR, the scope of work of the SWG would cover data collection, genetic study and other relevant activities to support stock assessment on neritic tunas, mackerel species (seerfish), and the other important pelagic fishes, as well as for the management of neritic tunas and the other important pelagic fishes in Southeast Asian waters.

Conservation and management of Indo-Pacific mackerels

Indo-Pacific mackerel (*Rastrelliger brachysoma*) is one of the most economically important small pelagic species found throughout the Southeast Asian waters. However, catch production of the species from countries in the region had gradually declined. In order to ensure that the species could be utilized in sustainable manner, SEAFDEC has therefore extended its support to countries in the region through several programs and projects to enhance the capacity of their fishery officers and to gather information in order to obtain better understanding on the stock status of the species. It is expected that such information would serve as basis for a proper science-based management decision for sustainable utilization of the species in the future.

The SEAFDEC–Sweden Project "Fisheries and Habitat Management, Climate Change and Social Well-being in Southeast Asia" which was implemented from 2013–2019 and the SEAFDEC/UNEP/GEF Fisheries *Refugia* Project also jointly developed in 2019 the draft of "the Regional Action Plan (RAP) for Management of Transboundary Species: Indo-Pacific Mackerel in the Gulf of Thailand Sub-region" which was approved by the SEAFDEC Program Committee at its Forty-second Meeting in 2019. To follow-up on this, the RAP was submitted and approved by the Fifty-second Meeting of the SEAFDEC Council in 2020. Subsequently, the RAP was submitted to the Twenty-third Meeting of the ASEAN–SEAFDEC FCG/ASSP in November 2020 and would be submitted to the ASEAN mechanism to seek policy

support and promote its implementation. The RAP covers five (5) dimensions, namely: 1) ecosystem, 2) social, 3) economic, 4) governance, and 5) climate change, and aimed at achieving "sustainable Indo-pacific mackerel fisheries in the Gulf of Thailand Sub-region by 2030 through a holistic management approach."

1.8 Capacity building towards sustainable fisheries

Promotion on Strengthening of SEAFDEC Visibility and Enhancing Human Capacity Building

From 2014 to 2019 SEAFDEC/TD implemented two Departmental Programs: Tailor-made Training Programs, and Strengthening of SEAFDEC Visibility and Image. In 2020, the two programs were merged as **"Promotion on Strengthening of SEAFDEC Visibility and Enhancing Human Capacity Building."** The activities undertaken by TD in 2020 included:

- Arranging of exhibition displays and games with the theme "fishery resources conservation" during the 2020 celebration of the National Children's Day of Thailand on 11 January at the Prachunlajomklao Navy Dockyard at the mouth of the Chao Phraya River, Samut Prakan Province

The National Children's Day

- Donation of the income (318,700 Thai Baht) generated from the special activity "SEAFDEC Mini-marathon: Fisherman Run-Save the SEA" which was organized on 8 December 2019 to six schools around TD as scholarship grants, and for purchase of medical equipment for Prasamutchedi Sawathayanon Hospital on 10 and 13 January 2020, respectively

Donation of incomes from "SEAFDEC Mini-marathon 2019: Fisherman Run-Save the SEA" as scholarship grants to six schools around TD and buying of medical equipment for Prasamutchedi Sawathayanon Hospital

- Welcoming of 59 visitors who are students from schools and universities in order to enhance their experience outside the classroom. During the visit, the role of SEAFDEC and its mission in the region was introduced, and the visitors subsequently observed the M.V. SEAFDEC and TD facilities.

Visitors from Ranong Fisheries Association

Students from Kasetsart University

Students from Kasetsart University during their visit to TD

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

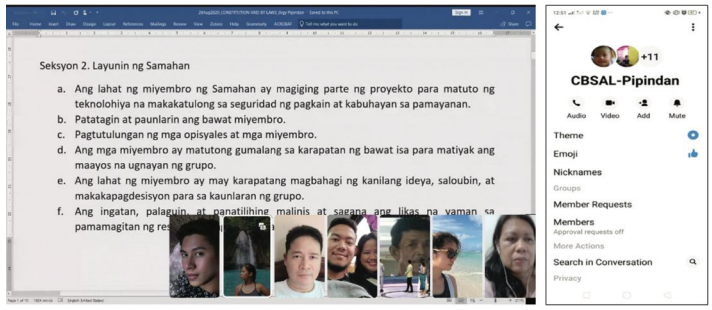
2.1 Sustainable Aquaculture through Cost-effective Culture Systems and Prompt and Effective Aquatic Animal Health Management

In 2020, SEAFDEC/AQD started a new regional project **"Sustainable Aquaculture through Cost-effective Culture Systems and Prompt and Effective Aquatic Animal Health Management"** which would be implemented from 2020 to 2024 with support from the Japanese Trust Fund. The Project was implemented to carry over and strengthen the activities and achievements from its previous project "Promotion of Sustainable Aquaculture and Resource Enhancement in Southeast Asia," implemented from 2015 to 2019. The expected outputs of this new Project are: 1) Development of strategies and technologies for aquaculture production in Southeast Asia; 2) Development procedures in disease control and management against crustacean and fish diseases; and 3) Capacity enhancement on sustainable aquaculture and aquatic animal health management in Southeast Asia.

- ***Community-Based Hatchery, Nursery, Grow-out of Giant Freshwater Prawn***

Laguna de Bay, better known as Laguna Lake, is the largest lake in the Philippines. Together with its tributaries, it has been an essential economic contributor to aquaculture production. However, for years, the lake has been facing numerous problems that constrain its sustainable development. This study is, therefore, aimed at developing the strategies for securing food and livelihood for fisherfolks through the promotion of full-cycle aquaculture of high-value indigenous species such as the giant freshwater prawn (GFWP) or *Macrobrachium rosenbergii*, and exploring its ranching potentials in Laguna Lake and its tributaries.

As travel and community quarantine restrictions brought about by the COVID-19 pandemic challenged the implementation of the study's activities in 2020, virtual meetings and telecommunication methods became the modality to carry out the activities for the study. Discussions on the nature of the collaboration had been pursued between AQD and the concerned local government units, and also with fisherfolk stakeholders, as social preparation and community organizing were initiated, and the project agreement and the constitution and by-laws of the fisherfolk association were drafted. A tri-party collaboration with stakeholders in target Barangay Pipindan in Binangonan, Rizal, namely: the fisherfolks, local government, and AQD, was also agreed through the online meetings. Thus, rapid site assessment for GFWP hatchery and feasibility study has been ongoing.



Screenshots of online meetings between AQD and its collaborators

For 2021, this study will validate the results of the socioeconomic baseline survey with stakeholders and train fisherfolks on GFWP hatchery and nursery. Subsequently, the construction and operation of community-based GFWP hatchery and nursery will commence through collaboration with grow-out farmers.

Promoting Alternative Feeds for Sustainable Production of Freshwater Aquaculture Species

Considering that feeds are the most expensive input in aquaculture, it is necessary to continue the development of alternative feeds for freshwater aquaculture species such as tilapia, giant freshwater prawn, and tropical anguillid eels. Currently, the aquaculture industry is expressing great interest in the abovementioned species. With that, AQD initiated the development of sustainable feed technologies using alternative feeds and feeding strategies in culturing freshwater species to promote small-scale aquaculture in Southeast Asia. This year, the study tested the effects of feed reduction strategies on tilapia

growth performance, given alternative feeds containing fermented okara meal in cages and tanks.

Two tilapia growth trials were conducted in tank- and lake-based cage setup during the dry season. The setup used a 2 x 2 factorial design to compare two formulated tilapia feeds (containing bacteria-treated okara meal or BOM and yeast-treated okara meal or YOM) and two feeding strategies (daily feeding and alternate day feeding) with four replicate cages per treatment. Results showed that the two diets did not significantly affect the performance of Nile tilapia fingerlings after 16 weeks in tank-based cage trial. Furthermore, no significant difference in survival (93.75-96.25 %) and feed conversion ratio (1.22–1.30) were observed in fish fed two diets containing BOM and YOM. However, growth parameters were significantly affected by the two feed management strategies. Meanwhile, survival rate and feed conversion ratio did not show any significant difference in both treatment groups, while the interaction between the diet and feeding strategy was not significant, as shown in **Table 1.**

Table 1. Growth, survival, yield, and feed conversion ratio of Nile tilapia fingerlings reared in tank-based cage trial

Treatments	FW (g)	WG (g)	SGR (%/day)	Survival (%)	Yield (g/m^3)	FCR
Diet						
BOM	131.46	687.00	2.08	93.75	3,703.00	1.30
YOM	124.18	648.00	2.05	96.25	3,596.00	1.22
Feeding Strategies						
Daily Feeding	182.05^a	996.00^a	2.14^a	94.76	5,209.00^a	1.31
Alternating Day Feeding	73.59^b	340.00^b	2.00^b	94.58	2,090.00^b	1.21
Two-way ANOVA						
Diet (D)	NS*	NS	NS	NS	NS	NS
Feeding Strategies (FS)	<0.0001	<0.0001	<0.01	NS	<0.0001	NS
D x FS	NS	NS	NS	NS	NS	NS

*NS – not significant

In the lake-based cage trial, the two diets had no significant influence on the performance of Nile tilapia fingerlings after 12 weeks of culture. Mean survival rates and feed conversion ratio were also not significantly different in fish fed two diets. However, survival rates were much higher in the tank-based cage trial due to high water temperature-related (>32 °C) mortality of fish in the lake-based trial, particularly in April and May. Moreover, the two feeding strategies had a significant effect on the growth parameters of Nile tilapia in cages. Mean final weight, percent weight gain, specific growth rate, and final yield in groups fed daily were significantly higher than those fed on alternating days, as indicated in **Table 2**.

On the biometric measurements, the results showed that both diets and feeding strategies did not influence the condition factor and hepatosomatic index of Nile tilapia fingerlings in tank-based cage trial. This suggests that there was no difference in the physiological state of fish that underwent the treatments. However, a significant effect on the fingerlings' viscerosomatic index was detected in groups fed on alternate days. Meanwhile, for lake-based cage trial, significant effects on hepatosomatic and viscerosomatic indices were

noted in both diet and feeding strategies, although there was no significant difference observed in the fingerling's condition factor.

Table 2. Growth, survival, yield, and feed conversion ratio of Nile tilapia fingerlings reared in lake-based cage trial

Treatments	FW (g)	WG (g)	SGR (%/day)	Survival (%)	Yield (g/m^3)	FCR
Diet						
BOM	136.47	535.00	2.27	66.67	2,719.00	1.33
YOM	131.53	513.00	2.21	67.92	2,692.00	1.35
Feeding Strategies						
Daily Feeding	157.70[a]	628.00[a]	2.45[a]	68.75	3,249.00[a]	1.44
Alternating Day Feeding	110.31[b]	420.00[b]	2.03[b]	65.83	2,161.00[b]	1.24
Two-way ANOVA						
D	NS	NS	NS	NS	NS	NS
FS	<0.0001	<0.0001	<0.0001	NS	<0.0001	NS
D x FS	NS	NS	NS	NS	NS	NS

*NS – not significant

For 2021, another trial will be conducted in the wet season using the same experimental design as in the first trial. The preparation of the economic analysis to determine the most cost-effective feed and feeding strategy for possible adoption of fish farmers will also be included in the activities for 2021, then, alternative feed ingredients (*e.g.* aquatic weeds, black mussel, fish silage, and okara meal) will be evaluated as potential replacements for soybean meal and fishmeal in diets for tilapia in biofloc-based system.

Ecosystem Approach to Responsible and Sustainable Shrimp Farming

In order to increase the production and competitiveness of small-scale aquaculture farmers, mitigation and management of aquatic diseases are essential. One of the ecosystem approaches that could help minimize diseases and mitigate their occurrence, posed by sharing the same water source and having the same inlet and outlet, is through aquaculture clustering and zoning. In this approach, an aquaculture zone is identified, consisting of one or several clusters of farms including its water resources, where farms in a cluster are called aquaculture management areas (AMAs). With this, AQD started a study to establish aquaculture management plans that can improve production of small-scale shrimp farmers. In 2020, identification of aquatic organisms that has the ability to remove nitrogen from the water in a constructed and artificial wetland was initiated. Various organisms that included seaweeds (*Gracilaria* sp., *Eucheuma* sp., *Caulerpa* sp., *Kapppaphycus* sp.), pickleweed (*Salicornia* sp.), abalone (*Haliotis* sp.), sandfish (*Holothuria* sp.), oyster (*Crassostrea* sp.), and mussels (*Perna* sp., *Mytilus* sp.) were tested to purify the effluents in fish ponds. Water samples were collected before adding nitrogen, a day after addition of nitrogen, and weekly thereafter. After five weeks, *Caulerpa* and *Holothuria* have the best ability to remove ammonia, total ammonia nitrogen (TAN), and phosphate from the environments, followed by *Gracilaria*, *Eucheuma*, *Perna*, *Kappaphycus*.

These organisms were also evaluated for their ability to grow under brackishwater pond conditions, where the pond experiments to identify organisms that has the ability

to thrive under brackishwater pond environment, are ongoing. The organisms used in these experiments are *Caulerpa*, *Eucheuma*, *Gracilaria*, *Kappaphycus*, brown mussel, green mussel, oyster, and sandfish. After five weeks, *Holothuria* and oyster had the best ability to grow in brackishwater ponds as manifested in their increased weights followed by *Gracilaria*. All other organisms had decreased their weights significantly and not one brown mussel had survived. Daily salinity ranged from 23 to 35 ppm, and daily temperature was between 28.7 and 41.1 °C. Overall, the best candidates suitable for the constructed and artificial wetlands are sandfish, oysters, and green algae, as presented in **Table 3**.

Table 3. Mean nutrient level and mean weight increase of organisms in experimental tanks (suitable for artificial wetland construction)

Organism	Mean nutrient level (NH_4, TAN, PO_4) in experimental tanks	Mean weight increase (g)
Green algae (*Caulerpa*)	0.40	-1,333.3
Red algae 1 (*Gracilaria*)	2.37	-366.7
Red algae 2 (*Eucheuma*)	2.56	-2,883.3
Red algae 3 (*Kappaphycus*)	4.80	-1,166.7
Sandfish (*Holothuria*)	0.44	12.2
Mussel (*Mytilus*)	6.19	-1,283.3
Brown mussel (*Perna*)	3.45	-2,000.0
Oyster (*Crassostrea*)	9.93	483.3

For 2021, an artificial and constructed wetland for small-scale shrimp culture will be designed based on the organisms identified in the earlier stage of the study. Mesocosms of the designed artificial/ constructed wetlands will be established to determine the feasibility of the designs and will be used as basis for the pond experiment. Rectangular tanks (30 L capacity) filled with 4 cm sludge will be used for this study.

Development of Aquaculture Techniques on New Aquatic Species for Promotion and Creation of Local Aquaculture Industry

A study was carried out to establish seed production and grow-out techniques of various economically important species for the adoption of local aquaculture industry. This was specifically aimed at developing hatchery and grow-out techniques for: kawakawa (*Euthynnus affinis*), shortfin scad (round scad, *Decapterus macrosoma*), flathead lobster (*Thenus orientalis*), and seahorse (*Hippocampus comes*) that are commonly found in the nearby Municipalities of Tibiao and Anini-y in Antique Province, and Tigbauan in Iloilo Province. In 2020, live samples of shortfin scad were sourced from Antique Province and were transported to AQD's Tigbauan Main Station using 829 L insulated transport tank with continuous supply of pure oxygen for conventional aeration and temperature maintained at 26.7 °C, salinity at 33.8 ppt, and dissolved oxygen at 5.75 mg/L. Upon arrival, the 25 live samples were stocked in an 11.5-ton, flow-through rearing tank, and fed *Gobiupterus* sp. (locally known as "dulong"), dried shrimp, and *Acetes* sp. The fish responded well when fed with *Acetes* sp. Full procedures of sourcing, transporting, and stocking of the fish samples for the study are depicted in **Figure 1.**

Hauling of ring net in Anini-y, Antique

Hauling operation of otoshi-ami in Tibiao, Antique

Selection of live shortfin scad

Selection of live shortfin scad

Transport set-up

Fish cage materials in Tibiao, Antique (left) *and knotted netting used in current set-up* (right)

Stocking of live shortfin scad in flow-through tank

Feeding of Acetes *sp. to shortfin scad*

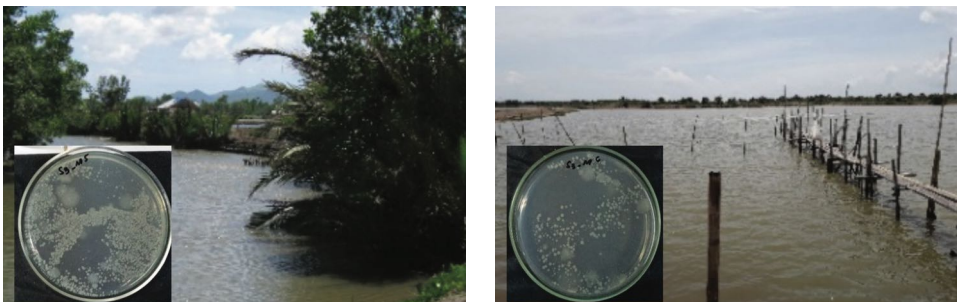
Figure 1. *Procedures of shortfin scad sampling adopted in the study*

For 2021, the standardized transport (from the wild to the tank-based facility) and tank-rearing and management protocols for kawakawa and shortfin scad will be established.

Development of Diagnostic Procedures to Determine Emerging and Unknown Crustacean and Fish Diseases

Viral and bacterial diseases have given rise to significant fish and shrimp farming constraints in most Asian countries and worldwide. Prevalence and occurrence of these diseases have contributed to the decreasing aquaculture production. Hence, developing disease diagnostic protocols for unknown and emerging diseases is the most efficient response to address these issues. This study was conducted to identify and profile the unknown and emerging crustacean and fish diseases in Philippine aquaculture farms, and subsequently, to develop and optimize bacteriological and molecular protocols, both conventional and real-time PCR, of these diseases. To identify the causative agents, AQD conducted an onsite assessment and mangrove crab sampling for disease diagnosis in 2020.

Results of bacteriological diagnosis showed that the average bacterial counts of weak crab samples were highly elevated (10^4–10^5) than the apparently healthy crab samples (10^2–10^3) in two sampling trips. The high bacterial counts on crab muscle tissue and hemoglymph can be traced on low-quality trash fish given to crabs. Molecular diagnosis however showed that all crab samples and the small wedge shell "agihis" (*Donax cuneatus*), a live feed given to crabs, were negative to the seven target pathogens. Meanwhile, histopathology observations indicated few parasitic plasmodial-like cell inclusions in the gill lamellae, infiltration and colonization of bacteria inside the hepatopancreatic tubules, and sloughing off of the hepatopancreatic tubules in both weak and apparently healthy crab samples. In terms of water quality, the physical appearance of the river water, where the samples were sourced, was turbid due to high sedimentation, and the two farms sampled were not practicing good aquaculture practices (GAqP), some facts that should be addressed.



Disease samples taken from two sites in Capiz Province

For 2021, AQD will monitor mass mortalities in aquaculture caused by unknown and emerging crustacean and fish diseases. This would entail isolation and identification of causative agents and the development and optimization of disease diagnostics protocols.

Survey of the Epidemiology, Distribution, Occurrence, and Prevalence of EHP

Enterocytozoon hepatopenaei (EHP) is an obligate intracellular microsporidian parasite that infects the tubules of hepatopancreas of shrimps, damaging the ability of the animals to gain nutrition from feeds. Although EHP might not cause mortality, it remains a major concern for shrimp farmers. This study aims to compile epidemiological information,

distribution, occurrence, and prevalence of EHP. Specifically, diagnosis, detection and confirmation of EHP infecting shrimps using wet mount preparation, histology and molecular diagnostic tools would be carried out, while the transmission mechanism of EHP in shrimps determined. From this study, AQD would develop and disseminate the guidelines and management measures against EHP. In 2020, shrimps (*P. vannamei*) were collected from a grow-out farm in Zarraga, Iloilo, to analyze the presence of EHP by wet mount, PCR, and histology. Preliminary results of the study using nested PCR and wet mount analysis indicated that detection of EHP was negative in all shrimp samples.

In 2021, active surveillance, distribution, occurrence, and prevalence of EHP in the Philippines would be continued. Diagnostic methods will be conducted, including squash preparation of HP, histopathology, PCR, and onsite hybridization.

In Vitro ***and in Hatchery Investigation of Organisms, Chemicals and Methods to Prevent or Mitigate the Effects of Important Shrimp Diseases***

Production of black tiger shrimp has been decreasing due to the occurrence of diseases that led to mortalities or affected the shrimp's growth. This study aims to investigate the organisms, disinfectants and chemicals, and methods that can be used to prevent the vertical and horizontal transmission of shrimp diseases at the hatchery phase. At the outset, verification of the Acute Hepatopancreatic Necrosis Disease (AHPND) prevention method in the grow-out phase identified in the previous years would be continued. Results of the study will be used to come up with the recommendations and guidelines on how to prevent shrimp disease transmission at the hatchery phase. Although studies have been done on egg disinfection, the efficiency of these disinfectants in eliminating recent pathogens had not yet been verified. The investigation of therapeutants and processes that can be used to disinfect *Peneaus monodon* fertilized egg, nauplii, and postlarvae is still ongoing.

In 2021, the investigation of therapeutants and processes that can disinfect shrimps' egg, nauplii, and postlarvae would be continued.

Application of Integrated Approaches in the Management of Viral Infections and Other Emerging Diseases in Brackishwater Ponds

In shrimp aquaculture, success in farming operations is highly dependent on the growth and survival of the farmed species, which in turn is determined by the occurrence and non-occurrence of disease outbreaks. This study aims to implement disease management by combining vaccination, immunostimulants and probiotics, antivirals, and Good Aquaculture Practices (GAqP), including biosecurity measures, and maintenance of water quality and health status of farmed shrimp. Simulated tank trials on the combination of two or more approaches against target pathogens as well as pond trials to demonstrate the efficacy of the integrated approaches would be carried out under this study. Guidelines for farm-based disease management specific for the target pathogens would also be developed. The treatments for the proposed experiments are presented in **Table 4**.

Table 4. Treatments for the experimental setup

T1	SPF PLs + disinfected pond soil and water + other BMs & BMPs (3 replicates)
T2	SPF PLs + non-disinfected pond soil and water + other BMs & BMPs (3 replicates)
T3	Non-SPF PLs + disinfected pond soil and water + other BMs & BMPs (3 replicates)
T4	Non-SPF PLs + non-disinfected pond soil and water + other BMs & BMPs (3 replicates)

SPF = specific pathogen free
PL = postlarvae
BMs = biosecurity measures
BMPs = best management practices

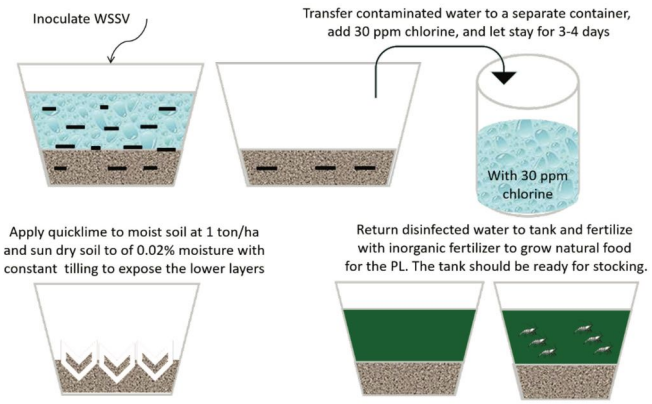


***Figure 2**. Procedure showing the simulated tank trials*

Capacity Enhancement on Sustainable Aquaculture and Aquatic Animal Health Management

Being mandated to encourage human resource development through research and extension, AQD makes sure that human capacity enhancement activities are always incorporated in its research activities. This project aims to capacitate participants from the ASEAN Member States (AMSs) with sustainable and appropriate technical knowledge and skills, new approaches in aquaculture nutrition, feeds and feeding strategies, through distance learning – a cost-effective yet convenient tool for e-learners. The target clients include fishery officers, researchers, fish farmers, farm managers and technicians, feed manufacturers, and college students.

The pandemic has prompted AQD to strengthen its online learning strategies in 2020 by making use of the new learning platform called Canvas instead of the usual eFront. Specifically, the 13-week Aquaculture Nutrition Online (AquaNutrition Online) course with nine revised and updated modules offered from September to December 2020, allowed the participants to test and be familiarized with the new platform a week before the courses started. Participants from the AMSs, accepted and registered to attend the ANOL course, included those from Brunei Darussalam, Cambodia, Indonesia, Myanmar, Philippines, and Singapore.

As for the distance learning course on the Principles of Health Management in Aquaculture (AquaHealth Online) which aims to disseminate knowledge, skills and new approaches in fish health management and increase capacity to manage aquatic animal diseases among stakeholders in the AMSs would be conducted using the Canvas as well. This 15-week online course has 14 modules and the expected participants are from the AMSs such as Brunei Darussalam, Cambodia, Philippines, and Viet Nam. Meanwhile, station-based and onsite training courses on nutrition and feed development were ultimately postponed until the COVID-19 situation improved.

Meanwhile, the training course for Marine Fish Hatchery offered annually by AQD is aimed at providing participants with the knowledge and skills on broodstock management, spawning, and larval rearing of marine fish species such as milkfish, sea bass, groupers, mangrove red snapper, rabbitfish, and pompano. Unfortunately, due to travel restrictions and health protocols imposed by the Governments of the AMSs, the course has been postponed until further notice. An online training course is being proposed to be developed with revised curricula and shortened duration as an alternative to the station-based program.

2.2 Improvement of broodstock and seed production technologies

Quality Seed for Sustainable Aquaculture

Aimed to generate, verify, and promote technologies to ensure the sustainable production of quality seed stock for aquaculture and stock enhancement, this program includes studies and activities that aim to determine the optimal conditions and cost-effective, science-based methods for producing quality seedstock. Enhancement of breeding performance using: (a) different modes of hormone administration to induce maturation in captive broodstock; (b) nutritional interventions, *e.g.*, formulation of broodstock diets and larval nutrition schemes; and (c) other non-genetic/environmental interventions, are the approaches being promoted.

- *Grouper*

Efforts to improve grouper aquaculture through breeding and seed production of giant and hybrid groupers have been in the verification stage in 2020. This study focused on inducing early gonadal development in captive groupers through an alternative mode of hormone administration, since hormones used for inducing breeders to spawn are typically injected. In this study, recombinant gonadotropin-releasing hormone (GnRH) in yeast was incorporated in artificial diets and fed to juvenile groupers. Results showed that *via* this mode, gonad development was effectively advanced. The protocol for a simple refrigerated storage at four degree Celsius of sperm using sucrose extender solution was also verified and applied in giant grouper, tiger grouper, and orange-spotted grouper. The extender solution can be used to store equal volume of sperm samples in 50 ml vial, and was effective in preserving grouper sperm motility and fertilization capacity up to two weeks. Trials on the application of refrigerated sperm for production of fast-growing hybrid groupers are being undertaken.

- *Abalone*

A study was conducted to verify the effectiveness of two AQD-developed broodstock diets in improving the reproductive performance of tropical abalone (*Haliotis asinina*). Diet 1 (37 % protein/3381 kcal kg^{-1} energy) and Diet 2 (42 % protein/3542 kcal kg^{-1} energy) were compared against the control diet seaweeds (18 % protein/2146 kcal kg^{-1} energy).

Results showed that regardless of the feeding treatment, all abalone breeders followed a 30-day spawning cycle. The spawning frequency was higher in abalones fed formulated diets but other reproductive parameters such as spawning rate, days to 1st spawning, and instantaneous fecundity showed no difference between the treatment (formulated diets) and control (seaweed) groups. Eggs produced by the seaweed-fed breeders had a significantly higher fertilization rate, but the hatching rate was lower than those breeders fed the formulated diets. Settlement rates 10, 20 and 30 days post-stocking were consistently higher in larvae of the Diet 2 breeders, except for Day 20, the values were not significantly different. Settlement rates of larvae from abalones fed formulated diets were consistent throughout the 30-day monitoring period compared to the declining trend shown by larvae of the seaweed-fed breeders (**Table 5**).

Table 5. Fertilization, hatching and settlement rates (10, 20 and 30 days post-stocking) of eggs and larvae produced by abalone breeders fed seaweed and two formulated diets.

Treatment	Fertilization Rate (%)	Hatching Rate (%)	Settlement Rate, 10 days (%)	Settlement Rate, 20 days (%)	Settlement Rate, 30 days (%)
Control, Seaweed	81.6±1.1^{b}	39.6±17.6^{a}	2.3±0.20	1.3±0.0^{a}	1.2±0.89
Diet 1	74.2±3.0^{a}	67.5±9.4^{ab}	1.7±0.45	1.7±0.44^{ab}	1.8±0.22
Diet 2	77.2±3.2^{a}	71.1±10.8^{b}	2.5±0.76	2.6±1.0^{b}	2.5±0.8

A study on production of abalone juveniles is also conducted to showcase the production technology developed by AQD as well as to support other abalone research conducted in-station. In this year's production, abalone survival rate ranged from 3 to 4 % per cropping as shown in **Table 6**. In order to improve the production, a feeding experiment was also conducted where the results showed that growth of the abalone juveniles fed seaweeds still gave a higher specific growth rate (4.2 %) than the juveniles fed the prawn diet (2.8 %) and the abalone diet (2.6 %).

Table 6. Abalone production in 2020

Larvae	Juvenile Production	Survival Rate
2,022,000 ind	67,500 ind	3.36 %

- *Mudworm*

Polychaetes are used as natural food either in pure form or in combination with other marine organisms and artificial diets to improve the reproductive performance of crustacean broodstock. In 2020, the mudworm species being studied by AQD is *Marphysa iloiloensis*, named after Iloilo Province in the Philippines, where the AQD's Tigbauan Main Station is located.

M. iloiloensis are being cultured in indoor tanks following a closed-culture system since 2016 to prevent pathogen contamination. Seawater supplied in all culture tanks were UV-sterilized. Sediments were disinfected using chlorine and screened for the presence of pathogen prior to use. Polychaetes were also sampled and screened for shrimp and fish pathogens. The stocking density experiment conducted in 2020 indicated that a stocking density of either 500 or 1,000 ind/m^2 gave the highest polychaete survival (40–48 %) with a bodyweight of 0.22 g after five months. Better survival was also observed when polychaetes were fed at 100 g/m^2 using feeds administered twice or thrice a week. An experiment using the best stocking density, feeding rate, and feeding frequency is ongoing.

Polychaetes spawn in broodstock tanks every week of each month, and a total of 881 jelly cocoons were produced in 2020 (**Figure 3**), an increase from 421 in 2019. Cocoons containing fertilized eggs were stocked in the nursery tanks and reared for 15 or 30 days and transferred to grow-out sediment tanks until adult stage. A total of 4.0 kg polychaetes were harvested in a culture area of 18 m^2, which were used as broodstock in the Polychaete Hatchery, and the rest were supplied to other AQD research studies. Polychaete production data in 2020 are shown in **Table 7**.

For 2021, polychaete production will be continued, and the cost-and-return analysis of tank-based polychaete culture technology will be investigated. In addition, polychaete jelly cocoons will be collected from the wild and grown in tanks to replace the old breeders. It is important to note that the last collection of jelly cocoons from the wild was in 2016–2017 and spawning has been taking place since then. Thus, it is necessary to replace the old breeders to avoid deterioration in the performance of the polychaetes used in mass production.

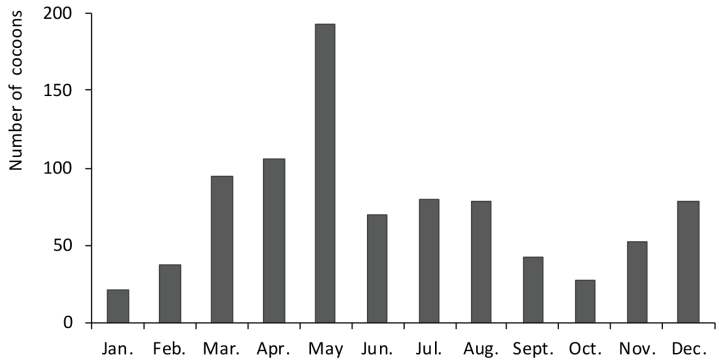


Figure 3. *Number of jelly cocoons produced in Polychaete Hatchery every month (in 2020)*

Table 7. Polychaete production data in 2020

Hatchery	
No. of breeder tanks	6
No. of breeders/tank (1 m^2)	300–500
Total no. of jelly cocoons	881
No. of fertilized eggs/cocoon	1,500–10,000
Grow-out	
Culture area (m^2)	18
Survival rate, % (1-day old to adult)	3-5
Body weight (g)	0.20–0.30
Biomass (g/m^2)	222
Total production (kg)	4.0

- *Black tiger and Indian white shrimps*

Biofloc-based aquaculture systems have progressed much because it is bio-secure with zero-water exchange, implying that water quality is improved within the system. Biofloc technology (BFT) is also financially-friendly, enhances growth, and boosts the immune system of species being cultured. Using this system, AQD conducted a study to determine if its adoption could help improve the quality of the water where shrimp juveniles are reared. In 2020, the experiment evaluated the effect of biofloc system using two different carbon sources against clear water culture on the growth and survival of shrimps (*Penaeus monodon* and *P. indicus*). Initial results shown in **Table 8**, indicated that the growth of *P. indicus* juveniles was better when provided with molasses as carbon source compared with the wheat flour and control (no carbon source) at 45 days of culture (DOC).

Table 8. Mean growth parameters of *Penaeus indicus* in a BFT system.

Growth parameters	Molasses	Wheat Flour	Control
Initial weight (g/shrimp)	**0.90**	0.90	0.90
Stocking density (pcs/m^3)	**180.00**	180.00	180.00
ABW (g/shrimp)	**3.01**	2.68	2.60
SGR (%/day)	**8.62**	7.79	7.58
Weight gain (%)	**234.44**	197.78	188.89

- *Mangrove crab*

Natural food such as green microalgae and rotifers are among the most critical components in the larval rearing of mangrove crabs. Maintaining its supply is one of the bottlenecks in the hatchery operation due to many factors such as weather conditions and contamination. A study using algal paste as an alternative feed for rotifers was therefore carried out in the larval rearing of mangrove crab *Scylla serrata*. In 2020, the performance of crab larvae given rotifers fed with three forms of algae, *e.g.*, fresh or live, flocculated, and centrifuged

algal paste, was assessed. As shown in **Figure 4**, there was no significant difference in the survival rate of mangrove crab larvae at DOC 4 when the three algal forms were compared. However, after DOC 24 (crab instar stage), a significantly high survival rate was observed in centrifuged paste (7.73 %) compared to flocculated paste (3.21 %) and fresh algae (1.08 %). However, in terms of growth, results show no significant difference.

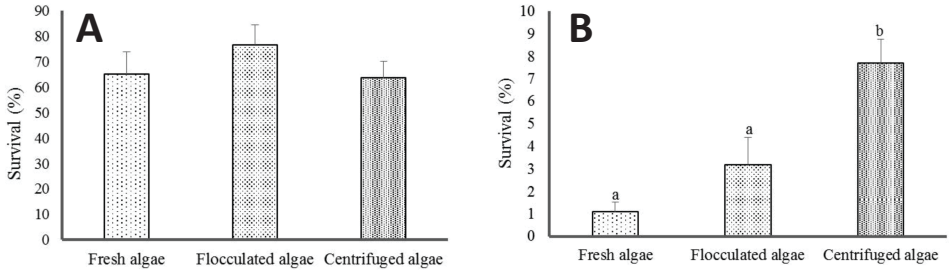


Figure 4. *Survival (%) (mean ± SE) of mangrove crab larvae fed with rotifers given-*Tetraselmis *in fresh, flocculated and centrifuged forms until day 4 (A) and from zoea 1 to crab instar (B) Bars with different superscript letters are significantly different (P < 0.05)*

Interests in mangrove crab culture had been increasing yearly, both locally and internationally. With this, AQD continued to develop and improve hatchery technologies in order to produce crablets, allowing the mangrove crab industry to be less dependent on wild-caught seeds or crablets. In 2020, feeding frequency was refined to improve seed production. As shown in **Figure 5**, survival rate of zoea 5 to crab instar was higher when fed 6-times (28 %) compared when fed 4-times (22 %). AQD's in-house crab hatchery continued to produce crablets to support research and verification studies as well as make good quality seedstocks available for interested stakeholders. **Table 9** shows that production of crablets increased from 656,200 pieces in 2019 to 817,000 in 2020 despite the COVID-19 pandemic hampering the hatchery activities.

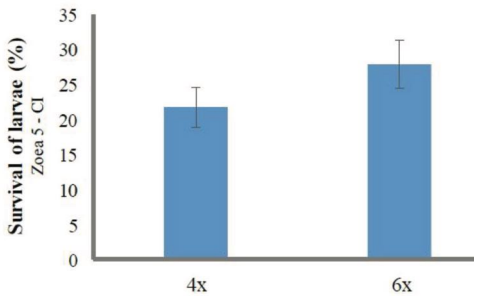


Figure 5. *Mean survival rate (%) of mangrove crab larvae from zoea 5 to crab instar (CI) at different feeding frequencies*

Table 9. Comparison of AQD's crab hatchery production from 2019 to 2020

Year	Crablets
2019	656,200
2020	817,000

- *Sea cucumber*

Constructed in 2010, the sea cucumber hatchery of AQD has an optimal capacity of five million larvae for rearing, and aims to produce early juveniles of sandfish *Holothuria scabra* to cater to various experimental studies of AQD that require sea cucumber seeds. The verification study conducted since 2018, has optimized sea cucumber seed production, targeting a survival rate of at least 5 % and a production volume of 20,000 juveniles per spawning batch. The study also seeks to determine the factors that affect the unstable production of sandfish year-round.

In 2019 and 2020, the target survival of >5% was achieved by some spawning batches, particularly around April and August. While four batches achieved production volume target of more than 20,000 per spawning batch, the highest was in June 2019 with 51,713 juveniles and in September 2020 with 45,779, many batches had produced juveniles below the target, resulting in an annual average volume of 13,000 juveniles at 1.25 % average survival rate. The unstable production was attributed to environmental factors since the hatchery is dependent on natural weather conditions. In particular, production was affected by (1) cold temperatures during January–February; (2) unstable supply of natural larval food around April and October; and (3) high precipitation and low salinity in July–September.

To address the various concerns, AQD installed an auto-heating system in the hatchery facility to improve larval development. Results indicated faster larval development in heated tanks (50 % doliolaria larvae at 14 days post-hatching) compared to larvae in unheated tanks (50 % at 19 days post-hatching). Additional hatchery enhancement includes an aeration filter system, and a larger capacity UV water treatment system. Separate studies also explored the use of concentrated microalgae as an alternative to live natural food.

- *Harpacticoid copepods*

Copepods contain essential nutrients that meet the nutritional requirements of marine fish larvae. AQD has been conducting experiments since 2019, to determine the optimal culture conditions of the harpacticoid copepod *Tigriopus* sp. in tanks. Since information on its biology and culture requirements are prerequisites for its sustainable mass production, the life cycle of *Tigriopus* sp. was successfully monitored and described in 2019. In 2020, the optimal culture conditions were determined, the results of which showed that highest population growth of harpacticoid could be achieved when cultured at ambient temperature (28–29 °C) at salinity of 30 ppt (**Figure 6**).

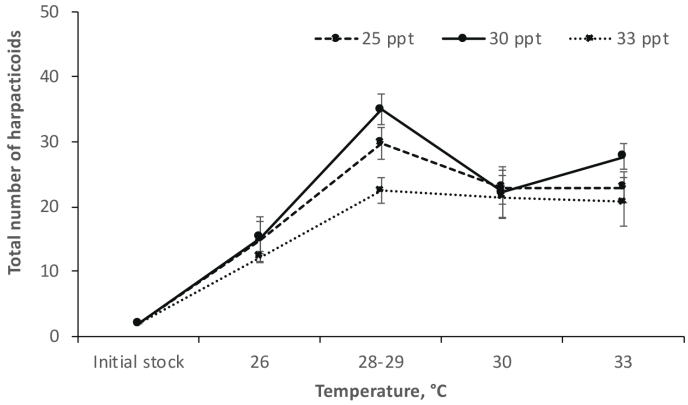


Figure 6. *Population growth of copepods under different temperature–salinity combinations*
Each point is presented as mean ± SE (n = 4)

An experiment was carried out using different biofloc concentrations (10, 20, and 30 ml/L) to determine the optimal concentration that could increase the population growth of harpacticoids. Results indicated that the harpacticoid population growth in each biofloc concentration increased with the culture days until day 40, and a sharp decrease was observed on day 50 in all biofloc concentrations (**Figure 7**). The highest population growth was on day 40 in all biofloc concentrations. **Figure 7** shows the highest population growth at 10 ml/L (202,500 ± 11,087 harpacticoids) followed by 20 ml/L (167,500 ± 8,539 harpacticoids) and lowest at 30 ml/L (97,500 ± 12,500 harpacticoids).

For 2021, a protocol for the large-scale culture of *Tigriopus* sp. in tanks will be established and its suitability for use as live food for the different species of marine fish larvae will be investigated.

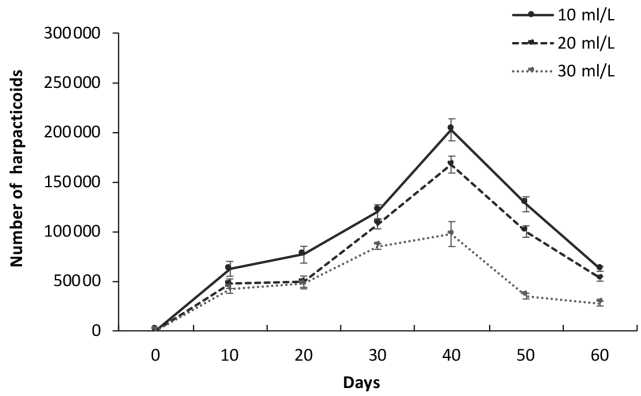


Figure 7. Tigriopus *sp. at different biofloc concentrations (10, 20, and 30 ml/L) for 60 days*
Each point is presented as a mean ± SE (n = 4)

- *Pompano*

Light or illumination is known to have effects in foraging of marine fishes, subsequently affecting their growth and survival. In a study carried out at AQD, illumination was used as one factor in the development of alternative and cost-efficient rearing techniques for nursery culture of pompano in sea cages. In 2020, the results showed that the culture period for pompano in lighted cages and fed 100 % of the feed ration was shortened by 15 days. The specific growth rates of pompano fed at 50 % and 75 % of the feed ration were not significantly different from those in unlit cages fed at 100 % of the ration and with pompano in lighted cages and fed 100 % of the ration. On the other hand, the feed conversion ratio was noted to be best in lighted cages where pompano was fed at 75 % feeding rate. Good growth of pompano in lighted cages could be due to higher zooplankton (calanoid and cyclopoid copepods) ingestion. As shown in **Figure 8**, pompano ingested more zooplanktons in treatments with illuminated cages during the earlier weeks of nursery culture, implying that pompano might have preferred live zooplankton during the earlier part of the nursery period.

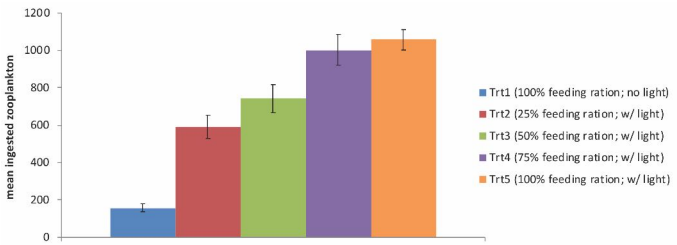


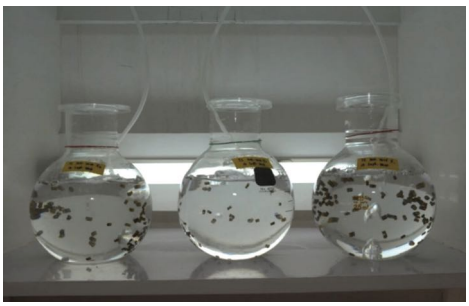
Figure 8. *Mean ingested zooplankton in five different treatments for 11 weeks of nursery culture*

- *Seaweeds*

Seaweeds are the number one commodity produced in aquaculture, and to sustain such production, it has become necessary to control diseases and pests that hamper the growth of eucheumatoids leading to insufficient production and lack of quality seedlings available for seaweed farms. Experiments had therefore been carried out by AQD to produce seaweed seedlings through micropropagation. One such study intends to produce seaweed micropropagules from its land-based laboratory to support the needs of its sea-based nursery. With the adoption of refined methods, propagule production increased from 4,000 to 7,200 individuals/month in early 2020, and from such production, 30 batches (two batches/month) of propagules from the land-based nursery (61,644 *K. alvarezii* and 2,449 *K. striatus* propagules) were successfully transferred to the sea-based nursery cages facility at Igang Marine Station in Guimaras, with average survival rates of 29.0 % and 84.0 % in *K. striatus* and *K. alvarezii*, respectively. In 2021, production is projected to double up to 15,000 upon the completion of the seaweeds laboratory expansion. Tank-acclimated seaweed micropropagules will then be produced under the approved study that aims to evaluate if tank acclimation favors better growth and survival over non-acclimatization when the micropropagules are later planted in the open sea.

On sea-based production of seaweeds, a study is being carried out by AQD to increase the production of seaweed propagules by improving the survival rate in expanded sea-based nursery cages. Although production is ongoing, the results showed initial production

of *Kappaphycus alvarezzi* and *K. striatus* propagules at 33,054 with 7,555 survivals in two months, which equates to total survival rate of 22.9 %. This was achieved by using laboratory-produced propagules acclimatized in seawater for 1–2 hours prior to stocking in sea cages at 250 ind/tray density.



Seaweed propagules production in AQD laboratory

- *Algal paste*

Considering that most commercially available microalgal paste is expensive in the Philippines and is not affordable for small-scale hatcheries, AQD carried out a study to determine the optimal conditions for the production of algal paste through electrolytic flocculation using important and locally available microalgal strains and aquaculture species, and identify the ideal current or power source, electrode materials, and harvest parameters, *e.g.*, biomass and time. In 2020, the study has defined the ideal power source, electrode material, and harvest time to produce algal paste using *Chaetoceros calcitrans*, *Tetraselmis tetrahele* and *Nanochlorum* sp. The best number and type of electrode for use in algal paste production are six pieces aluminum and six pieces lead for *C. calcitrans* and *T. tetrahele*. The highest biomass harvested for *C. calcitrans* is 0.646 kg using a 10-volt power source, while for *T. tetrahele* it is 1.7 kg using a 12-volt battery power source as shown in **Table 10.** Harvest time for *C. calcitrans* is shortest at 15 min using a 10-volt power source, while the shortest harvest time for *T. tetrahele* and *Nanochlorum* is 61 min and 78 min, respectively. The paste quality based on metal contents and storage conditions was also determined for the different species, particularly for *C. calcitrans*.

In addition, resuspension of *C. calcitrans* paste is possible up to six months of storage in freezer or chiller or in airconditioned rooms. *C. calcitrans* paste stored in the first two months using a chiller developed better lipid content while those stored in the freezer developed high carbohydrates and protein. *T. tetrahele* is best kept using a chiller without preservatives because its resuspension showed a lag phase of three days but peaked after six to eight days. The revival of *T. tetrahele* was not achieved when stored in the freezer. In the feeding of rotifer Brachionus with *T. tetrahele* paste, the highest count was achieved using 6/6 aluminum and steel electrodes at 7-volts. Meanwhile, feeding live *Nanochlorum* sp. to rotifers is still best compared to feeding with *Nanochlorum* sp. paste.

Table 10. Weight of microalgae produced in varying power voltages

Microalgae	Weight (kg)
C. calcitrans	0.646
T. tetrahele	1.700

- *Larval food*

A study to develop a modified continuous culture system was carried out to improve the mass production of the most commonly used live food for tropical marine hatcheries such as *Nanochlorum* sp. and *Brachionus rotundiformis*. Adaption of a modified continuous culture system in the hatchery is known to improve culture efficiency as this eliminates the tedious scaling-up of algal culture and reduces the number of culture tanks used. With the use of continuous feeding of the culture system with nutrient medium and exposing the microalgae to continuous lighting using a cool-white fluorescent tube, the algal outflow is directly fed to *B. rotundiformis*. The study will adopt a reduced substrate concentration of 50 mg/L nitrate using the temporary maximum residue limit (TMRL) culture medium since it promotes optimum growth rate for *Nanochlorum* sp. in batch culture.

Furthermore, the use of a ball valve and brass air controller resulted in a minimal fluctuation of the desired flow rate (inflow of nutrients). Benchmark turnover rate of 15 % and 30 % was identified as resulting in a stable and sustainable algal culture. Moreover, 30 ppm chlorine to treat seawater was observed to minimize the presence of ciliates.

For 2021, the abovementioned ongoing studies would be continued, as well as the population genetics and environmental-DNA (e-DNA) research on Anguillid eels which is funded by Japan–ASEAN Integration Fund and led by SEAFDEC/IFRDMD with assistance from AQD. To date, AQD has started optimizing the protocol for e-DNA extraction and DNA amplification using Mi Eel primers to detect and identify Anguillid eel species in water samples from AQD tanks at the Binangonan Freshwater Station where on-grown eel species are being maintained. A manual shall be written on the e-DNA protocol for use in future field samplings once travel can be made to sampling sites in Cagayan and Mindanao.

2.3 Ensuring food safety through sustainable aquaculture methods

Healthy and Wholesome Aquaculture

Healthy and wholesome aquaculture is an integral component in improving and sustaining aquaculture production to provide the protein needs of an escalating human population. R&D efforts in aquaculture have resulted in the sector's phenomenal growth during the last four decades. However, there are still problems that need to be addressed to attain significant improvements and assure the future generations' food security in the face of many challenges posed by ecological, economic, and climatic changes, among others, happening in our world today.

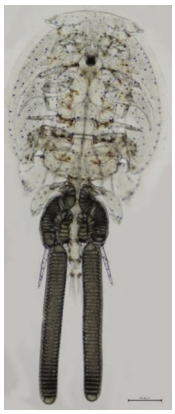
The Healthy and Wholesome Aquaculture Program of AQD has two main components: fish health, and nutrition and feed. While fish health concentrates on disease diagnosis, control, monitoring, and surveillance of aquatic animals; and environmental integrity, certification, and food safety, the nutrition and feed component focuses on studies to address problem areas to sustain the aquaculture production of the region.

- *Tilapia*

Tilapia lake virus (TiLV) is a viral disease that infects tilapia causing lesions and ulcers, eye abnormalities, reduced schooling behavior, and mass mortalities. A study was carried out by AQD to detect and quantify TiLV in pond soil, water, and fish samples using quantitative reverse transcription PCR (qRT-PCR), and so far, detection and diagnostic protocol for TiLV was optimized in 2020. Fish organs were dissected and preserved in 95 % ethanol at -20 °C for PCR analysis. Phylogenetic analysis of partial genome segment 3 sequences (179 bp) suggests that Group 1 and 3 were closely related to an Egyptian strain.

- *Caligus* sp.

Sea lice species of the family Caligdae, are most commonly reported in fish reared in brackish and marine waters. The species not only threaten the health of the fish but also have the potentials to endanger the fish stocks. A study was carried out by AQD to test which concentration dosage of emamectin benzoate (EMB), hydrogen peroxide, and onions is effective versus the sea lice. In 2019, after the life cycle of the *Lepeophtheirus spinifer* was completed, laboratory static bioassay was conducted to determine the 96-h LC_{50} of EMB on juveniles of the snubnose pompano, *T. blochii*. Results showed that the 96-h median lethal concentration (LC_{50}) was 0.32 ppm. In addition, the results showed that the orally-administered EMB on pompano at concentrations of 1.25, 1.39, 1.53, and 1.67 ppm, resulted in significant reduction of the prevalence and mean intensity of sea lice on 17- and 27-days post-treatment compared to the control.



Female
Lepeophtheirus spinifer

- *Catfish*

The occurrence of infectious diseases has hindered the sustainable production of pond-reared catfish in the Philippines. In an effort to determine the causes of the diseases, AQD conducted a study to address the sporadic occurrences of mortalities among hatchery-produced African catfish (*Clarias gariepinus*) in the municipality of Zarraga, Iloilo, through active monitoring and surveillance of the putative causative disease agents. In 2020, two catfish farms, *i.e.*, Catfish Farm A (commercial scale) and Catfish Farm B (small-scale), were monitored every two weeks over four months. In both catfish farms examined, the levels of physicochemical water parameters were within acceptable ranges, except for the higher levels of water hardness from one of the deep well sources that supplied water in the hatchery of Catfish Farm A. As shown in **Table 11**, the presumptive *Vibrio* counts (PVC) in the hatchery water were higher in Catfish Farm A than Catfish Farm B. Moreover, the presumptive *Aeromonas* counts (PAC) quantified in the nursery water, and sediment samples obtained from Catfish Farm A were also apparently higher than those obtained from Farm B. On the contrary, the PAC quantified in fingerling samples obtained from Catfish Farm A nursery were one log lower than those fingerling samples collected from Farm B.

Table 11. Summary of bacterial counts in the water, sediment, and catfish samples obtained from the hatchery and nursery of Catfish Farm A and Farm B

Culture Phase	Sample	Parameters	Farm A (commercial scale)	Farm B (small-scale)
Hatchery	Water	Physicochemical parameters	Not significantly different except hardness ($CaCO_3$)	Not significantly different
		Presumptive *Vibrio* Count	$\leq 10^4$ cfu/mL (100% Yellow colonies)	$\leq 10^3$ cfu/mL (100% Yellow colonies)
	Fry	Presumptive *Vibrio* Count	$\leq 10^5$ cfu/g (100% Yellow colonies)	From undetectable (UD) at 10^{-1} dilution to $\leq 10^5$ cfu/g (100% Yellow colonies)
Nursery	Water	physicochemical parameters	Not significantly different except hardness	Not significantly different
		Presumptive *Aeromonas* Count	$\leq 10^4$ cfu/mL	$\leq 10^3$ cfu/mL
		Presumptive *Vibrio* Count	UD at 10^{-1} dilution	from UD to $\leq 10^2$ cfu/mL (100% Yellow colonies)
	Sediment	Presumptive *Aeromonas* Count	$\leq 10^5$ cfu/g	$\leq 10^3$ cfu/g
		Presumptive *Vibrio* Count	$\leq 10^4$ cfu/g (100% Yellow colonies)	from UD to $\leq 10^3$ cfu/g (100% Yellow colonies)
	Fingerlings	Presumptive *Aeromonas* Count	$\leq 10^5$ cfu/g	$\leq 10^6$ cfu/g

- *Marine fish*

Outbreaks of viral nervous necrosis (VNN) in Asian sea bass, groupers, and pompano at the larval stages via vertical transmissions of nervous necrosis virus (NNV) from asymptomatic broodfish remain a major deterrent during the seed production of these species at AQD. To address such concern, a study was carried out to primarily verify the practical application of the vaccination regimen as an effective strategy to produce NNV-specific-free eggs coming from immunocompetent (vaccinated) high-value marine broodfish species reared in floating net-cages at Igang Marine Station in Guimaras. In 2020, several marine fish species at the Igang Marine Station were intraperitoneally (IP) vaccinated with the formalin-inactivated NNV vaccine (pre-inactivation titer: $10^{10.5}$ $TCID_{50}$ $fish^{-1}$) from March to July 2020 (**Table 12**). The annual booster vaccination of these high-value marine fish species enumerated in **Table 12** will be conducted in 2021.

Specifically, to elucidate the effectiveness of the vaccination regimen in preventing vertical transmissions of NNV, pompano (*Trachinotus blochii*) broodfish were chosen as the experimental fish species. A group of pompano broodfish was then IP-vaccinated with formalin-inactivated NNV vaccine with a pre-inactivation titer of $10^{9.2}$ $TCID_{50}$ $fish^{-1}$. Another group of pompano broodfish was also injected with L-15 medium to serve as a control. Serum samples from both vaccinated and unvaccinated (control) pompano broodfish were collected and examined for NNV-neutralizing antibody titers at different time points post-vaccination. The mean NNV-neutralizing antibody titers quantified in the sera of vaccinated pompano broodfish at one- and two-months post-vaccination were 1:1729 and 1:5042, respectively. On the contrary, NNV-neutralizing antibodies were not detected (<1:40) in the sera of unvaccinated fish.

Table 12. High value marine fish species vaccinated with the formalin-inactivated NNV vaccine in 2020

Fish Species (Total Number)	Mean body weight (±S.D.)	Date of Vaccination
Pompano (*Trachinotus blochii*) (Vaccinated) (24)	1.68 ± 0.46 kg	5 June 2020
Pompano (*T. blochii*) (Control) (23)	1.48 ± 0.21 kg	5 June 2020
Sea bass (*Lates calcarifer*) (13)	5.39 ± 1.03 kg	10 August 2020
Hybrid grouper (*Epinephelus* sp.) (11)	4.50 ± 0.71 kg	10 August 2020
Orange spotted grouper (*E. coioides*) (4)	1.68 ± 0.67 kg	10 August 2020
Brown marbled grouper (*E. fuscoguttatus*) (4)	7.20 ± 1.73 kg	10 August 2020
Snapper (*Lutjanus argentimaculatus*) (14)	2.99 ± 1.62 kg	11 September 2020

- *Pompano*

Spray-dried hemoglobin (SDH) powder meal is a good source of protein. To determine the proximate, amino acid, and fatty acid compositions of hemoglobin meal, AQD carried out a study which aims to assess the digestibility of hemoglobin meal in a carnivorous fish. Then, an efficacy evaluation of the meal used as an ingredient in pompano diets would be conducted, to evaluate the performance parameters, feed efficiency, and comparative body composition (amino acid, proximate, and fatty acid profile). Due to the poor results gathered in the first runs conducted in October 2019 and January 2020, a second growth experiment run was conducted at AQD's Igang Marine Station in Guimaras. Six test diets were used with the following SDH diet levels: 0, 4, 6, 12, 18, 27 percent. Fish with initial body weight of 0.85 g were stocked in 1 x 1 x 2 m floating net cages. After 90 days, the results (**Figure 9**) showed that test diets 1 and 2, which has 4 % and 6 % SDH dietary inclusion, has higher average body weights (ABW) than the others, while the two test diets also have lower feed conversion ratio (FCR).

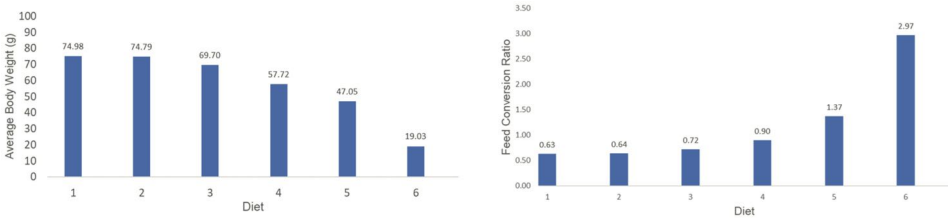


Figure 9. *Final ABW and FCR of pompano-fed with SDH*

Dietary protein is the most expensive component in feeds, comprising 70 % of intensive fish farming production costs. Therefore, the determination of essential amino acid requirements of fish is necessary to develop cost-effective feeds. The study carried out by AQD to determine the leucine, isoleucine, and histidine requirements of pompano had been started with the assessment of leucine requirement in 2020. The results showed that the optimum requirement is about 1.5 % leucine in the diet. This inclusion level gave the optimum weight (38.62±3.08), FCR (1.14±0.07), and survival rate (82.21 %), as shown in **Table 13**. The requirements for the two other essential amino acids will be evaluated in 2021.

Table 13. Growth performance of pompano fed different dietary leucine levels

Parameters	Diet 1 (0 %)	Diet 2 (0.5 %)	Diet 3 (1.0 %)	Diet 4 (1.5 %)	Diet 5 (2.0 %)	Diet 6 (2.5 %)
Initial weight (g)	4.87±0.28	4.81±0.19	4.79±0.11	4.82±0.23	4.81±0.34	4.80±0.26
Final weight (g)	29.22±2.18	32.31±2.03	42.98±3.44	38.62±3.08	32.56±2.93	27.19±3.16
FCR	0.88±0.08	0.89±0.07	0.95±0.08	1.14±0.07	1.09±0.06	0.94±0.07
Survival (%)	77.00	77.77	75.48	82.21	88.84	71.15

- *Milkfish*

With the increasing interest in using plant protein sources for fish feeds due to their relatively low cost and ample availability, AQD conducted a study to evaluate the efficacy of phytase and carbohydrase feed additive in milkfish diets. Phytase supplementation in fish feed could increase bioavailability of nitrogen which leads to reduction of feed cost. Meanwhile, carbohydrase enzyme tends to improve digestibility and reduce nutrient excretion. In 2020, experiments were conducted using a floating net cage set-up where milkfish were fed to satiation at estimated 4 times a day. The dietary treatments are shown in **Table 14**, while the partial results (**Figure 10**) indicated numerical differences which will be undergoing statistical analysis.

Table 14. Summary of treatments and components

Treatments	Components
Reference Control	Commercial Diet (CD)
Positive Control	CD + Phytase and Carbohydrases, reduce 50 % mono calcium phosphate (MCP)
Negative Control	Reduce 50 % MCP, 10 % soybean meal (SBM)
Enzyme Control	Negative control + Phytase and Carbohydrases

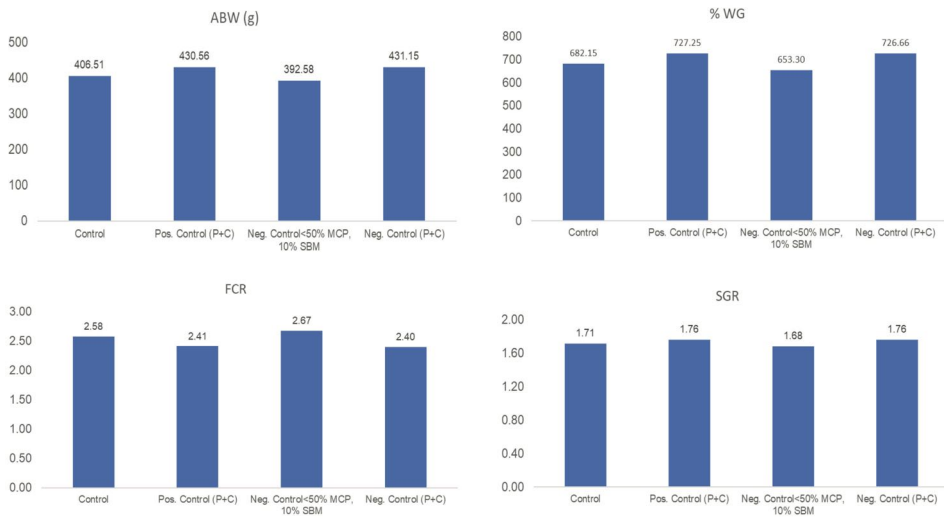


Figure 10. *Data showing the results of all dietary treatments*

- *Tiger shrimp*

Macroalgae were considered potential food sources for cultured aquatic organisms. The use of *Chaetomorpha* seaweed as a food source, either through inclusion in formulated feeds or by direct feeding through a co-culture system, can potentially benefit cultured shrimps and possibly other farmed aquatic species as well. This study aims to evaluate unfermented, fermented, and live green macroalgae (*Chaetomorpha linum*) as a food source. Testing several fermentation methods showed the use of koji mold (*Aspergillus oryzae*) is more effective in improving the nutritional value of *Chaetomorpha* meal than lactic acid bacteria (LAB) and yeast. Pre-treatment of fresh *Chaetomorpha* with weak acid also increased its protein and considerably reduced its ash contents.

A 90-day feeding experiment showed shrimps (BW~ 0.3±0.05 g) given diets with 0 %, 6 %, and 12 % inclusion of unfermented *Chaetomorpha* meal (UCM) have no significant difference in terms of SGR (2.6±0.29 to 3.0±0.16) and %weight gain (1022±318 % to 1484±225 %). However, the optimum level appears to be closer to 6 %. Hepatosomatic index (3.9±0.52 to 4.5±0.34) and survival rate (80±22 % to 89±8 %) were likewise the same in all treatments, even at 18 %, the highest inclusion level tested. Meanwhile, feeding trials using diets containing increasing levels of LAB and yeast fermented *Chaetomorpha* meal (LYFCM) resulted in highly variable data. Another run testing the inclusion of fungus-fermented *Chaetomorpha* meal (FFCM) is being conducted.

C. linum *harvested in AQD hatchery wastewater catchment facility*

- *Indian white prawn*

Penaeus indicus, which is an important shrimp species and indigenous to the Philippines, is capable of osmoregulation in a wide range of water salinity and has good reproductive performance. In 2020, AQD conducted hatchery production experiments to produce sustainable supply of *P. indicus* postlarvae from hatchery-bred broodstock. The 120 pairs of male and female broodstock produced 5,845,594 eggs and 4,230,890 nauplii with 40.5 % spawning, and 72.4 % hatching rate. From such production, 3.3 % survival rate was achieved resulting in 141,063 postlarvae, as shown in **Table 15**. The postlarvae were then used in other AQD studies while the excess were given to a collaborator. Fifty pieces of milkfish weighing 100 g each were polycultured with shrimp (two pieces postlarvae per m^2) in a 3,000 m^2 pond area, and the collaborator reported that the shrimps already weigh 6 g after 45 days of culture.

Table 15. Hatchery production of *Penaeus indicus* from February to August 2020

Month of Culture	Size of broodstock	Eggs	Nauplii	% spawn	% rematuration	Hatching rate (%)	PL	Survival (%)
Feb–March	♀ 12 ± 0.14 ♂6.25 ± 0.04	1,270,865	924,697	41	29	73	47,210	5.0
April–May	No production due to quarantine measures							
June–Aug	♀14.60 ± 0.18 ♂7.31 ± 0.08	4,574,729	3,306,193	40	37	72	93,853	2.8
Total		**5,845,594**	**4,230,890**	**40.5**	**33**	**72.4**	**141,063**	**3.3**

In order to reduce the risk of introducing pathogens to aquaculture production systems, research efforts are directed on closing the life cycle of cultured shrimp species in captivity. AQD conducted a study to improve the reproductive performance of the *P. indicus* by providing a maturation diet with optimized protein and lipid levels supplemented with polychaete extract vitellogenesis promoting factor. In 2019, *P. indicus* broodstock were fed with dietary treatments with varying protein (55 %, 45 %, and 35 %) and lipid (18, 12, and 6) combinations following a 3 × 3 factorial design. The control group was fed with fresh frozen squid, mussel, and polychaete. As a result, 45/18 and 55/12 protein/lipid levels were determined as the best dietary treatments with maturation rates not significantly different compared to the control group ($p = 1.9 \times 10^{-4}$). However, hepatopancreas damage

and gonadal atresia were apparent in treatments with high dietary lipid (45/18) based on histological and biochemical analyses. The diet with 55/12 protein/lipid combination was therefore best recommended for *P. indicus* gonad maturation.

In 2020, the effects of three polychaete extracts, namely: total soluble fraction (TSF), polar lipid fraction (PLF) and neutral lipid fraction (NLF), were supplemented to the basal data at three different concentrations (0.25 %, 0.50 %, 1.00 %). Ten dietary treatments in triplicates including basal diet were formulated and fed to adult male *P. indicus* for 21 days. Initial results suggested that lower concentration (0.25 %) of total soluble fraction, polar lipid fraction and neutral lipid fraction extracts from polychaete resulted in higher sperm counts per body weight in grams (**Figure 11**).

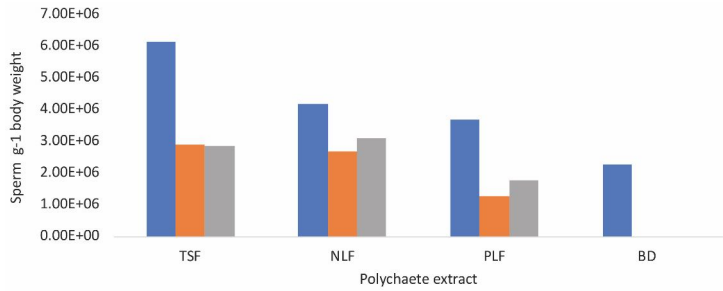


Figure 11. *Sperm counts per body weight (g) of male* P. indicus *broodstock fed with polychaete extracts (TSF, NLF, PLF) at three different concentrations (0.25, 0.50, 1.00 %)*

- *Abalone*

Abalone culture is a lucrative business. However, the grow-out culture of abalone in the Philippines is still dependent on *Gracilariopsis heteroclada*, an economically-important seaweed farmed for agar production and human consumption, as abalone feed. In 2020, AQD conducted a study to test the feasibility of using a new SEAFDEC-formulated diet for grow-out culture of abalone and will be subjected to comparison with *G. heteroclada.* Nine artificial diets were formulated, prepared, and analyzed for moisture content and water stability, and were tested for two, four, and six hours. The proximate compositions of the nine diets were: 26.27 to 32.55 percent protein; 4.40 to 5.42 percent fat; and 30.56 to 37.96 percent nitrogen-free extract (NFE) with energy ranging 278.72–302.77 kcal/100 g. From these nine diets, four were chosen based on nutrient and energy content, cost, and stability rate. These four diets will be tested for acceptability and actual feeding trials will be carried out in the succeeding experiments.

- *Silver therapon*

Silver therapon is one of the most valuable native freshwater species in the Philippines because of its tasty flesh. Due to intense fishing pressure, natural populations had been dwindling. To alleviate the pressures on the wild populations, efforts are now being done to conserve this fish species through a research study carried out by AQD on its domestication. Successful developments were done at AQD in previous years including the establishment of protocols for hormone-induced spawning and rearing of larvae up to juvenile stage in outdoor concrete tanks. From such developments, it is now necessary to establish a reliable

nursery and grow-out technique for silver therapon. In 2020, experiments were conducted to determine the optimal stocking densities for this species in the nursery. Using three stocking densities (50/m^3; 75/m^3; and 100/m^3), performance of early stage silver therapon juveniles reared in tank- and land-based cages were examined. Results **(Table 16)** indicated that early stage silver therapon juveniles stocked at 50–100/m^3 showed comparable growth and survival. However, early stage juveniles reared in tank-based cage nursery grew better than those reared in lake-based cage nursery. Experiment is now ongoing to determine the optimum dietary protein level in grow-out feeds for silver therapon.

Table 16. Effect of stocking density on the performance and biometric indices of silver therapon fry reared in tank- and lake-based cages

A. Tank cage nursery

	Density groups		
	50/m^3	**75/m^3**	**100/m^3**
Final weight (g)	2.12 ± 0.23	1.93 ± 0.32	2.10 ± 0.01
Weight gain (%)	1,296.00 ± 199.00	1,098.00 ± 253.00	1,194.00 ± 105.00
Specific growth rate (%/day)	4.17 ± 0.22	3.92 ± 0.32	4.06 ± 0.13
Survival (%)	93.30 ± 6.10	90.20 ± 5.00	84.00 ± 7.00
FCR (feed conversion ratio)	2.50 ± 0.34	2.55 ± 0.05	2.32 ± 0.09
Condition factor	1.46 ± 0.07	1.50 ± 0.03	1.48 ± 0.01
Hepatosomatic index (%)	1.47 ± 0.05[a]	1.17 ± 0.10[b]	1.52 ± 0.08[a]
Viscerasomatic index (%)	15.59 ± 1.08	17.18 ± 1.29	15.86 ± 1.36
Gut index (%)	4.88 ± 1.93	4.52 ± 0.60	5.08 ± 0.20

B. Lake cage nursery

	Density groups		
	50/m^3	**75/m^3**	**100/m^3**
Final weight (g)	2.12 ± 0.23	1.93 ± 0.32	2.10 ± 0.01
Weight gain (%)	1,296.00 ± 199.00	1,098.00 ± 253.00	1,194.00 ± 105.00
Specific growth rate (%/day)	4.17 ± 0.22	3.92 ± 0.32	4.06 ± 0.13
Survival (%)	93.30 ± 6.10	90.20 ± 5.00	84.00 ± 7.00
FCR (feed conversion ratio)	2.50 ± 0.34	2.55 ± 0.05	2.32 ± 0.09
Condition factor	1.46 ± 0.07	1.50 ± 0.03	1.48 ± 0.01
Hepatosomatic index (%)	1.47 ± 0.05[a]	1.17 ± 0.10[b]	1.52 ± 0.08[a]
Viscerasomatic index (%)	15.59 ± 1.08	17.18 ± 1.29	15.86 ± 1.36
Gut index (%)	4.88 ± 1.93	4.52 ± 0.60	5.08 ± 0.20

For 2021, studies on tilapia lake virus, shrimp, and seaweeds would be continued while a new research study on the verification control, treatment, and intervention protocols against sea lice, is being proposed. Finally, vaccination of marine fishes will be incorporated as one of the demonstration activities at AQD's Igang Marine Station in Guimaras.

2.4 Development of responsible and sustainable aquaculture technologies

Maintaining Environmental Integrity through Responsible Aquaculture

This Program was developed to address the adverse effect of aquaculture on the environment and find the ways to minimize these impacts. The phenomenal growth of aquaculture caused modification, destruction or complete loss of habitat; unregulated collection of wild broodstock and seeds; translocation or introduction of exotic species; loss of biodiversity; introduction of antibiotics and chemicals to the environment; discharge of aquaculture wastewater; salinization of soil and water; dependence on fishmeal and fish oil as aquaculture feed ingredient, to name a few. In an effort to address these concerns, AQD has been developing aquaculture technologies for various finfish species, crustaceans, mollusks, seaweeds, and other emerging aquaculture species to boost production in the Philippines and other countries in Southeast Asia, while also taking the lead in the development and promotion of eco-friendly aquaculture strategies.

- *Milkfish*

Aquaculture feeds account for about 70% of operational expenses in milkfish cage culture. Efforts to improve production efficiency have focused on reducing feed costs as well as optimizing feeding strategy. AQD has been studying compensatory growth (CG) in milkfish, as CG enables rapid growth after a period of food restriction and provides an opportunity to reduce feed input. The study seeks to determine the optimum duration of food restriction that primes the CG response in milkfish fingerlings and assess the minimum duration of refeeding. The study was also set to develop a feeding technique based on optimum starvation-refeeding cycle in a full grow-out culture of milkfish in marine cages. In 2019, physiological studies on milkfish fingerlings have shown that two to four days of starvation caused depletion of liver energy reserve (*i.e.* hepatosomatic index or HSI), significant reduction in circulating glucose, and increased plasma cortisol level – conditions that are stimulative of CG mechanism. Results of experiment looking into physiological recovery during period of refeeding have shown that HSI quickly recovered after one day of refeeding however the fish condition (Fulton's K) took at least 7 days to attain values comparable to that of the control group. Moreover, full recovery of lost body weight took about 11–12 days. Genetic analyses of appetite hormones during period of starvation and refeeding are being done to verify these phenotypic observations.

In 2020, actual cage culture trial was conducted to test two feeding schedules: cycles of 4 days of no feeding followed by 6 days of refeeding (4/6), and cycles of 5 days of food restriction and 5 days of refeeding (5/5). Initial results showed compensation of body weight and length after refeeding however it was only sustained up to two cycles (*i.e.* 20 days) while subsequent cycle of starvation and refeeding showed loss in body weight and length. **Figure 12** shows morphometric changes in milkfish fingerlings subjected to various feeding schemes. These results further show the need for longer period of refeeding for complete recovery. Subsequent trials will evaluate longer periods of refeeding to ensure full compensation of body weight throughout the period of grow out culture.

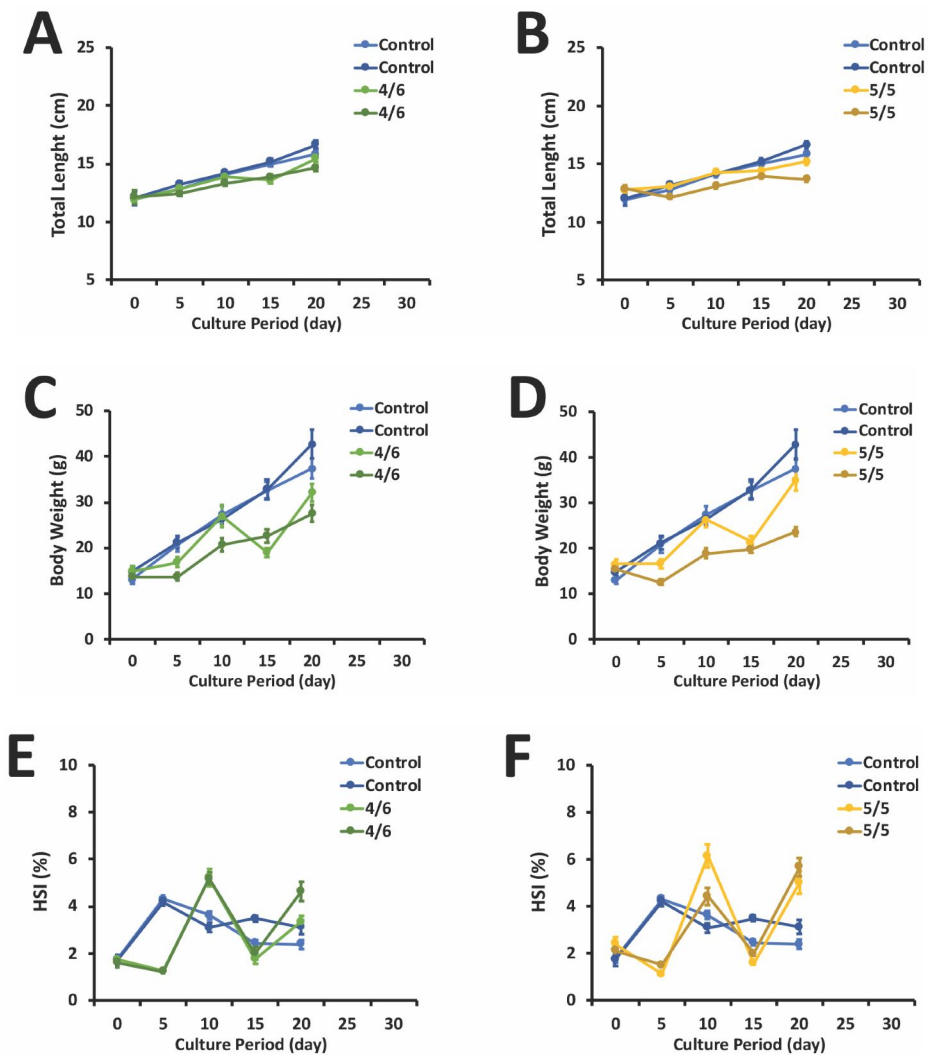


Figure 12. *Morphometric changes in milkfish fingerlings subjected to various feeding schemes: total length (A), body weight (B), HSI (C); for total length and body weight, each point is a mean of 40 individuals ± SEM, while each point in HSI is a mean of 15 individuals ± SEM*

- *Sea cucumber*

Sea cucumbers have high commercial value in the Chinese markets and are actively being traded in Southeast Asian countries. Overfishing these echinoderms in many parts of the tropics combined with poor fisheries management, resulted in severe decline of wild stocks. The recent collaborative project funded by the Australian Centre for International Agricultural Research (ACIAR) is aimed at developing appropriate hatchery and field culture methods for sandfish in Viet Nam and the Philippines. Results of the project studies have improved the knowledge of factors influencing ocean nursery culture and the site selection for sandfish ranching. At AQD, the use of microalgae concentrates as a practical replacement of live feed in the larval rearing of sandfish had been explored. Initial results indicated that

the use of commercial products of concentrated *Isochrysis* sp. and a mixed-diatom diet is promising, although the larvae fed with live *Chaetoceros calcitrans* showed the best performance. Further studies are planned to explore the larval development performance of locally-produced micro-algae concentrates, including those produced by AQD.

Results of the experiments in ocean-based nursery culture of sandfish in floating hapa nets suggested that algal biofilm and temperature positively affect sandfish growth, while wind and rain are negative factors. A study on predation was also conducted, and results showed that medium-sized (15–20 g) sandfish juveniles were observed to avoid predators. In comparison, smaller ones (<5 g) seem to be naïve and can be more prone to predation mortality. Field experiments on predator-mitigation strategies were also started in 2020 at AQD Igang Marine Station (IMS) using sandfish pens. Preliminary results showed that pens with higher nets promoted faster growth and higher survival of sandfish than semi-open pens with lower nets, where active effects of predation can be inferred.

Sandfish pens for predation experiments at Igang Marine Station in Guimaras

- *Tilapia and giant freshwater prawn*

Nile tilapia is now easy to rear to marketable sizes since its farming technologies are well-established. On the other hand, the giant freshwater prawn *M. rosenbergii* has also been successfully domesticated, bred, and grown locally, making prawn monoculture, particularly in ponds and lake-based cages, viable. This study aims to jointly produce two commercially-valuable low input species in a sustainable, cost-efficient, and responsible culture system that would provide profitable returns for small-scale fish farmers. Specifically, the study will look into rearing of a genetically-improved Nile tilapia strain (i-Excel) and a red tilapia hybrid, together with giant freshwater prawns (GFP) in tank-based co-culture systems and assess the optimal tilapia-prawn co-culture schemes in lake-based cages. In 2020, a five-month trial was conducted in a lake-based set-up. Nile tilapias (i-Excel) and red tilapias were stocked in nets within larger cages where GFP was stocked. The experiment has three feeding treatments including: a) tilapia fed floating feeds while prawns are unfed; b) tilapias fed floating pellets and prawns fed sinking shrimp diets; and c) tilapias unfed while prawns are fed sinking shrimp diets.

Results as shown in **Table 17** indicated that from the first run, mean survival of the GFP was higher in the treatment where both the tilapias and GFP were fed (62.2 %) while red tilapias survived better whether these are fed or unfed (56.0–81.3 %). Average weight gain was highest for the i-Excel tilapia whether or not they were fed or unfed. It is worth noting that these values have yet to be corrected when the survival data is used as a co-variate

in the analysis. In general, the prawns did not grow well when they were unfed. All the co-culture experiments will continue in 2021 and the economic viability of the various rearing systems will be evaluated by the end of 2021.

Table 17. Results of first rearing trial in cages at week 20

Treatment	Mean survival (%)			Average weight gain (g)		
	GFP	Red	i-Excel	GFP	Red	i-Excel
Fed tilapia only	50.56	78.67	54.67	28.48	**176.04**	243.16
Fed both tilapias and GFP	**62.20**	56.00	45.33	61.03	169.35	**272.08**
Fed GFP only	42.23	**81.30**	**64.00**	**75.03**	55.00	60.39

- *IMTA: milkfish, sandfish, and seaweeds*

The Japan International Research Center for Agricultural Sciences (JIRCAS) and AQD collaboratively explored the development of an Integrated Multi-Trophic Aquaculture (IMTA) which involves a system of culture that makes use of different aquatic organisms of various trophic levels. For this project, milkfish was used as the fed species, with sea cucumbers and seaweeds as extractive species. This approach could potentially allow farmers to maximize aquaculture production while minimizing their environmental impact. Since 2015, the project explored various IMTA systems and design, from the traditional 2D-IMTA where all species occupy the same water column, to a 3D IMTA where extractive species were located adjacent to the fish pen. In the recent runs in 2019 and 2020, the concept for four-dimensional (4D-IMTA) system was utilized (**Figure 13**). This concept involved culturing sandfish in the same milkfish area or pen after the fish has been harvested which means no additional feeding will be done. The remaining organics may be positively utilized by sandfish for enhanced growth, while helping in faster recovery of the sediments during this fallow period. The project was conducted in Barangay Pandaraonan in Guimaras in collaboration with the local government unit and fisherfolks.

During the culmination of the project, it was found out that the traditional 2D-IMTA system was problematic because there was not enough space for all commodities. The 3D-IMTA worked better, but since the culture duration differed among species, the 4D system was used to allow more time for growth, particularly for the sandfish. However, the experimental and small-scale design of the project resulted in heavy predation for both the seaweeds and sandfish. In effect, there was difficulty in achieving significant bioremediation effects from the current scale of sandfish and seaweed in this open pen system. Nevertheless, the project was able to demonstrate profitable proceeds from the milkfish component. The project also provided useful data in projecting the viability of the IMTA system at scale. At the same time, the project promoted awareness among the partner local community members of the aquaculture and monitoring methodologies of the three species, which they can apply in future ventures.

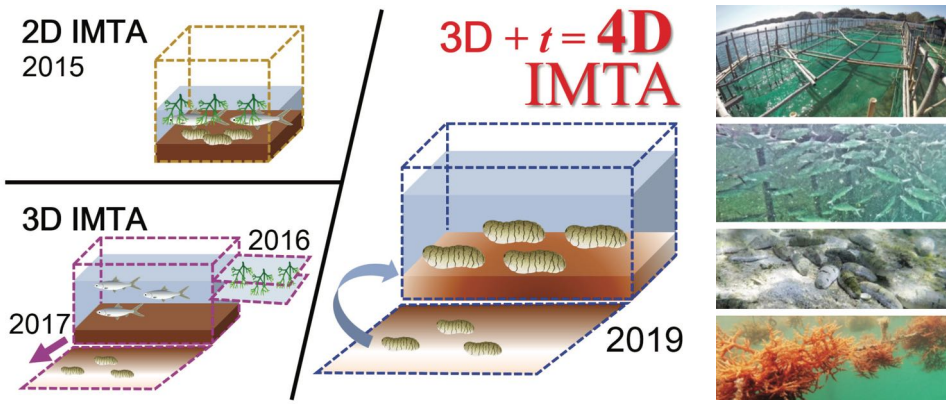


Figure 13. *Evolution of the IMTA pen system, utilizing milkfish, sandfish, and seaweeds*

- *Abalone*

Due to its high commercial value worldwide, abalone has become one of the most important fishery resources, and extremely valuable resources to local fishing communities. AQD started growing abalone in pipes under a three-year project funded by the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development of the Department of Science and Technology (DOST-PCAARRD), and since it showed promising results, AQD partnered with Ayala Corporation in verifying the effectiveness of this newly-developed grow-out culture technology in a large-scale project in Sicogon Island. From 2018, a total of 7,320 juveniles were stocked in six batches in the culture site, resulting in the harvest of 3,513 individuals in eight occasions until the study was completed in December 2020. Mortalities and missing stocks were caused by two typhoons that directly hit the site in 2019, plus starvation due to intermittent feeding caused by COVID-19 travel restrictions.

AQD staff stocks abalone in the trial area in Sicogon Island at the commencement of the project in 2018 with Ayala Corporation

Newly-harvested live abalone

- *Polychaete*

Due to their qualities that enhance reproductive performance, marine worms are incorporated into maturation diets. As emerging diseases become one of the most pressing issues affecting the aquaculture industry, the production of biosecure polychaetes became a preferable alternative. Thus, a study to verify the methods developed for the culture of *Marphysa* sp. in raceway ponds was carried out, the results of which showed that optimum stocking density of 500 ind/m^2 gave higher biomass (0.56 g, 100 g/m^2) when cultured for four months, crude protein (64 %) is most elevated within four months of culture, and crude fat (10 %) is peaked in three months in which 3.2 % is polyunsaturated fatty acids with high levels of arachidonic acid (20:4n-6), eicosapentaenoic acid (22:5n-3) and docosahexaenoic acid (22:6n-3). After three months, soil organic matter was utilized from initial of 5.1 % to 4.0 % while pH was improved from 2.8 to 6.3, available sulfur was reduced from 1890 ppm to 105 ppm, and iron was reduced from 55 ppm to 51 ppm indicating soil bioremediation capacity of the polychaete.

Experimental raceway ponds at AQD

For 2021, studies on strategic feeding of milkfish, fish-and-prawn co-culture, IMTA, and community-based sea cucumber production would be continued. For the studies on polychaetes and abalone in pipes which were completed in 2020, information materials, *e.g.*, manuals would be produced for dissemination to the stakeholders. Continuing projects will work on the remaining activities while new proposals and activities would be proposed to achieve the overall goals of the program.

2.5 Generation of appropriate technologies for rural aquaculture to provide livelihood and alleviate poverty

Meeting Social and Economic Challenges in Aquaculture

This program aims to develop and implement social and economic strategies in aquaculture and resource management to secure food and income through stakeholder collaboration. This is in response to the specific recommendations for meeting the social and economic challenges in aquaculture that were identified and adopted during the *ASEAN–SEAFDEC Fish for the People Conference* in June 2011.

- *Community-based projects: Giant Freshwater Prawn*

The study which aims to promote full-cycle aquaculture of high-value indigenous species such as the giant freshwater prawn (GFP) and explore its ranching potential in Laguna Lake and tributaries is ongoing as reported in (2.1). However, since travel and community quarantine restrictions brought about by the COVID-19 pandemic challenged the implementation of the study's activities, virtual meetings and telecommunication methods had been used to continue the activities for the study.

- *Community-based sandfish farming*

Sandfish has been a prestigious food and an important traditional medicinal item, increasing its demand which in turn caused depletion of these high-valued seafood products in the wild. In order to address this concern, AQD conducted a study that aims to assess the capacity of island-based fishing communities towards sandfish farming livelihood and develop strategies to increase and sustain the participation of fishing community members in sandfish farming. In 2020, a network of collaborators from across the Philippines conducted the preparation for the project. A workshop on qualitative social research methods survey was hosted by the AQD team and attended by partners such as the University of the Philippines Marine Science Institute (UP-MSI), Guiuan Development Foundation, Inc. (GDFI), and Mindanao State University (MSU)-Marawi Campus, and resource persons from the University Technology of Sydney (UTS). A memorandum of agreement was finalized together with fisherfolks in Molocaboc Island in Sagay City and the local government.

Specifically under the Western Visayas node being implemented by AQD, the project finalized the social survey instruments for household, traders, and key informant interviews which were uploaded in Qualtrics™, an offline data-gathering application that stores and seamlessly uploads and transmits completed surveys in a database when connected to the internet. Furthermore, 41 household surveys of Molocaboc Sea Ranchers Association (MOSRA) Fisherfolks were conducted online via the Facebook™ Messenger platform due to COVID-19 pandemic local travel restrictions around the Philippines. However, the Eastern Visayas node implemented by GDFI completed 60 % of its face-to-face interview activities while compliant with the prevailing COVID-19 safety measures and practices in Maliwaliw, Guiuan, Samar Province. The remaining 40 % will be continued in another study site during the first quarter of 2021. Meanwhile, the Mindanao (UP-MSU) and Luzon (UP-MSI) nodes will begin their social surveys when the community quarantine mandates are lifted and new local partners and expansion sites are identified. Both nodes will likely start social surveys in early 2021.

MOA signing of MOSRA by President Rafael Muñez *and* Vice President Dennis Abog *witnessed by members* Mr. Joebert Muñez and *the late* Mr. Mariano Jarina

MOSRA fisherfolk household virtual interviews via FB Messenger

In 2021, community-based studies will continue, and the project is expected to encourage the people of the communities to engage in aquaculture of commercially-viable species through capacity-building.

2.6 Compilation of scientific data and information to support policy on sustainable aquaculture

Adapting to Climate Change

Climate change is a compounding threat to the sustainability of aquaculture development. Impacts occur due to gradual warming, the increasing acidity of the oceans and associated physical and chemical changes, and frequency, intensity, and location of extreme climatic events. These changes affect the aquaculture organisms in general, as well as the different aquaculture systems and structures, the various support systems to aquaculture operations, and the fish farmers in the region are highly vulnerable since they depend on their aquaculture operations for food and income. Urgent adaptation measures are required in response to the threats to food and livelihood provision due to climatic variations.

In 2020, several activities under the other Departmental Programs have addressed the objectives of this program. Information on climate change impacts on aquaculture is incorporated in all AQD training courses.

In 2021, AQD will continue to incorporate climate change-resilient practices in its studies as well as in its training and information materials. The program is expected to generate and integrate scientific information related to the regulation and preparation of the industry, fish farmers, and other stakeholders to the effects and impacts of climate change.

2.7 Collaborative Projects with the Philippine Government

Over the years, AQD has developed technologies in broodstock management, seed production, and grow-out of economically-important finfishes, crustaceans, mollusks, and seaweeds. AQD believes that in order to truly make a change in the aquaculture industry, such science-based technologies and approaches must be ably and strategically applied on the ground, piloting these in the Philippine setting. The Government of the Philippines has embarked on priority projects that aim to address longstanding problems in the aquaculture sector such as shortage of fry, increasing prices of feed, and inadequate training efforts among others, with the ultimate goal of accelerating fish production and export revenues from the aquaculture sector. Against such a backdrop, AQD partnered with the Philippine Government through the Department of Agriculture-Bureau of Fisheries and Aquatic Resources (DA-BFAR) and other government organizations, in various aquaculture programs and activities that include:

- *Fry Sufficiency Program*

With the main objective of finding a solution to the problem of seed insufficiency in the Philippines, this Program which was launched after the signing of the Memorandum of Agreement (MOA) between DA-BFAR and AQD, involved construction and operation of more hatcheries, rehabilitation of unproductive hatcheries, and enhancement of the performance of milkfish breeders.

Site feasibility studies. In accordance with the MOA, continued preparation of feasibility studies was done on legislated areas with the prospective sites that were proposed. Unfortunately, ongoing site assessments for places with no feasible sites proposed were largely not done given the current pandemic situation. In the 15 sites listed in the MOA, progress of the Legislated Multi-Species Hatchery Program as of 2020 has substantially slowed down due to the COVID-19 pandemic. Site selection surveys and construction site visits were halted because of the ongoing travel restrictions. Under such circumstances however, AQD continued to work on the feasibility studies for two sites located in Surigao City in Surigao del Norte (RA 10825) and the Municipality of Hinatuan in Surigao del Sur (RA 10944).

As of December 2020, AQD has already completed six feasibility studies and submitted to the respective BFAR Regional Offices and local government units (LGUs). In one (1) site in Lingig, Surigao del Sur (RA 10787), construction of hatchery has already started and is halfway from completion. Meanwhile, at the site in Del Carmen, Surigao del Norte (RA 10825), construction has not yet started while awaiting for their Environmental Compliance Certificate (ECC), while the construction in Jabonga, Agusan del Norte (RA 10813), the only multi-species freshwater hatchery proposed, had been paused as the contractor required additional budget to address the embankment issues within the site, and the concerned BFAR Regional Office and LGU have yet to release the needed supplementary funding. It is expected that construction of the multi-species marine hatchery in Lingig, Surigao del Sur will be finished in 2021 and the hatchery in Del Carmen, Surigao del Norte is also expected to start its construction around the first half of 2021 once the ECC is secured. After the necessary evaluations and other

requirements for the eventual operation are finished, the first run of the hatchery would start immediately.

Due to the pandemic, site evaluations and engineering layout creation for the remaining legislated areas with no suitable sites presented have been temporarily put on hold in 2021. Meanwhile, the feasibility studies for Surigao City, Surigao del Norte, and Hinatuan in Surigao del Sur are expected to be finished by the early part of 2021. In the meantime, bidding for the multi-species marine hatcheries in Perez, Quezon (RA 10945) and Sultan Naga Dimaporo, Lanao del Norte (RA 10860) shall commence under the supervision of their respective LGUs. Once accomplished, construction of the said facilities could start in 2021.

Profiling unproductive hatcheries. Profiling of abandoned, operating or non-operating hatcheries in the First District of Iloilo had been carried out by AQD, the results of which indicated that nine (9) hatcheries are operating and used to culture tilapia, *Litopenaeus vannamei*, *Penaeus monodon*, milkfish, and seabass. On the other hand, twelve hatcheries were listed as abandoned or non-operating due to the owners' sickness or death, bankruptcy or lack of finances to continue operation. Most abandoned hatcheries used to culture *Penaeus monodon* during those times when there was high demand for this commodity. Rehabilitation and construction of multi-species hatcheries had been ongoing in Northern Iloilo Polytechnic State College (NIPSC), Concepcion, Iloilo, and in Batan, Aklan. Profiling of hatcheries in the area was done to serve as baseline information in the rehabilitation of non-operational hatcheries to maximize the production of milkfish fry in this region. The profiled operating, abandoned or non-operating hatcheries would be assessed based on the stability of the tanks, the accessibility of the area, ownership rights, and others. Some of these hatcheries would be repaired and improved to be legislated hatcheries in the area. The repair and improvement or rehabilitation of these hatcheries is under the collaborative efforts of AQD, BFAR, and the private sector.

- *Development of Cost-Efficient Feeds*

In partnership with BFAR and the National Fisheries Research and Development Institute (NFRDI), AQD is continuing its activities on identifying and utilizing feed ingredients that are cost-effective and can be used as alternatives to fishmeal. Field testing of cost-effective aquafeeds continued in 2020 with the main objective of reducing aquaculture production cost through the formulation of sustainable, cheap and nutrient rich feeds for milkfish and tilapia. For milkfish, experiments were conducted in Guiuan, Eastern Samar, where milkfish with an average body weight of 50 g were stocked in floating net cages (4 × 4 × 3 m) at a stocking density of 20 fish/m^3. Two dietary treatments were compared (cost-effective feed formulation and commercial diet), each treatment has three replicates, and conducted for 100 culture days. The results indicated that the body weight gain and feed efficiency of milkfish fed both the dietary treatments did not show significant difference. Likewise, survival was not significantly different between the two treatments (> 90%). The tilapia experiments were conducted at AQD's Dumangas Brackishwater Station (DBS) in Iloilo, where sex reversed tilapia with average body weight of 32 g were stocked in brackishwater ponds at a stocking density of 2.1 every square meter. The results indicated that tilapia fed the cost-effective feed formulation has a significantly higher weight gain and feed efficiency compared to tilapia fed the commercial diet. However, survival was not significantly different between the two

treatments (> 80%). In 2021, field-testing of cost-efficient diets will continue in Sto. Rosario in La Union for milkfish cage culture, and in Taal, Batangas for tilapia and milkfish cage culture.

- *Oplan Balik Sugpo (Revival of Tiger Shrimp Culture Program)*

To ensure the Program's success, AQD equipped its shrimp hatchery complex with its own spawner/broodstock facility for pathogen detection of newly-arrived spawners. This facility was a good investment since the hatchery uses spawners from the wild, which requires processing and analyzing before and after spawning to detect pathogens. The shrimp hatchery has produced disease-free fry that were stocked in the ponds at Dumangas Brackishwater Station in May 2020. A newly-installed shower room and waiting area inside the shrimp hatchery was built as part of the strict implementation of biosecurity inside the hatchery premises. For the record, around 2.2 million disease-free post-larvae shrimp were harvested in 2020. In 2021, production of disease-free fry in the hatchery will be continued following the same strict biosecurity protocols implemented in 2020. The project also plans to push through with the acquisition of specific pathogen free spawners.

- *Accelerated Techno-Transfer*

Due to government-mandated health and safety protocols against COVID-19, AQD had to postpone most of its onsite training courses. However, the Department managed to conduct one onsite training course in 2020 when health and travel restrictions have loosened. The onsite training course on freshwater aquaculture was conducted by AQD in the Municipality of Zarraga in Iloilo Province last 1 to 3 July 2020. Approximately 50 fishpond owners, farmers, and operators from the different municipalities in Iloilo participated in the training course conducted in collaboration with BFAR Region 6. This three-day course was composed of lectures on freshwater commodities (*e.g.*, catfish, giant freshwater prawn, and tilapia) and other special topics, and a simulation activity regarding induced spawning of catfish. Proper health protocols, such as physical distancing and wearing of face masks, were strictly observed during the training. Extension work and technology transfer of aquaculture technologies developed by AQD will continue in 2021, with BFAR identifying the potential venues for the next onsite training courses.

- *Manpower Development*

Sixteen graduates from different fisheries schools in Western Visayas were trained during the "Training Course on Manpower Development for Shrimp, Marine Fish, and Tilapia Aquaculture" to enhance their capabilities and broaden their perspectives and experiences in terms of aquaculture. They were trained on shrimp and multi-species marine fish hatchery operations, and cage and brackishwater pond culture operations. After three months of intensive training, they were employed by AQD and assigned to different areas and hatcheries at Tigbauan Main Station, such as Marine Fish Hatchery, Shrimp Hatchery, Mangrove Crab Hatchery, Integrated Finfish Broodstock and Hatchery Complex, Freshwater Hatchery, and Training and Information Division.

3. Strategy III: Ensuring the food safety and quality of fish and fishery products for the Southeast Asian region

3.1 Promotion of seafood quality assurance systems for fish processing establishments in the region

Enhancing Food Safety and Competitiveness of Seafood Products

Fisheries and aquaculture are some of the key industries in the ASEAN region, supplying not only the local demand for food fish but also the export market to meet the world's growing demand for seafood. However, the perishable nature of seafood poses challenges in maintaining its quality and safety, hence there is the need to develop good handling practices and build competencies in new preservation technologies. Rapid deterioration of quality due to irreversible processes such as microbiological metabolism, oxidative reactions and enzymatic activity takes place soon after capture and/or harvest of seafood. In order to safeguard the freshness and safety of seafood products, extend their shelf life and maintain their nutritive quality and economic value from catch to consumer, good handling practices and technologies are crucial.

For foods such as sushi and sashimi, Good Manufacturing and Handling Practices (GMP & GHP) should be put in place to guide their production. As sushi and sashimi are minimally processed and consumed raw, they pose a higher microbiological risk compared to cooked foods. GMP & GHP will be able to mitigate such risks while maintaining the quality, freshness and nutritional content of the products. Besides GMP & GHP, new preservation technologies such as High Pressure Processing (HPP) can also enhance the safety of seafood products. HPP is a cold pasteurization technique that subjects sealed products to high pressures through a water medium. Microorganisms that may cause food spoilage such as bacteria, viruses, yeasts, molds, and parasites are inactivated by the high pressure. Since no heat is applied to the products during the process of pasteurization, the nutrition, texture and flavor of the food products are preserved. Some examples of Ready-to-Cook (RTC) foods and ready-to-eat (RTE) produced using HPP are shucked shellfish and ready-to-cook seafood in sauce.

To introduce such technologies for possible adoption by countries in the Southeast Asian region, MFRD embarked on its new Project **"Enhancing Food Safety and Competitiveness of Seafood Products,"** comprising two tracks: 1) development of Regional Guidelines on Good Manufacturing and Handling Practices (GMP & GHP) for Sushi and Sashimi, and 2) development of HPP Protocols for Seafood. The development of these resources will allow for the adoption of GMP and GHP for high-risk foods such as sushi and sashimi, and serve to strengthen regional capabilities in safe handling of high-risk seafood products, as well as allow Member Countries to gain knowledge about new preservation technologies, enhancing the value, safety and quality of seafood products. The duration of this Project is from 2020 to 2024.

Due to COVID-19 travel restrictions, the inception meetings for both tracks of the Project planned in 2020 were conducted virtually. The meetings aimed to understand the existing local regulations that pertain to sushi and sashimi production, and the current state of

adoption of HPP in the AMSs. The scope and range for both tracks of the project were discussed and agreed upon by the participating Member Countries.

*Group photos taken during inception meetings for Track I: Regional Guidelines on Good Manufacturing and Handling Practices (GMP & GHP) for Sushi and Sashimi (*top*) and Track II: High Pressure Processing (HPP) Protocols for Seafood (*bottom*)*

For the year of 2021, MFRD planned to develop Training Materials for GMP & GHP for sushi and sashimi and conduct the Regional Training Course on GMP & GHP for sushi and sashimi, under Track I (Regional Guidelines on Good Manufacturing and Handling Practices (GMP & GHP) for Sushi and Sashimi). In addition, under Track II (High Pressure Processing (HPP) Protocols for Seafood), MFRD would carry out R&D and product development, and develop training materials for HPP of fish and fishery products. A Handbook on HPP of fish and fishery products will also be prepared.

4. Strategy IV. Enhancing trade and compliance of the region's fish and fishery products with market requirements

In 2020, there was no project implemented under the Strategy IV on Enhancing trade and compliance of the region's fish and fishery products with market requirements.

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

5.1 Monitoring and enhancing awareness on international fisheries-related issues

Assistance for Capacity Development in the Region to Address International Fisheries-related Issues

Issues related to trade of fish and fishery products have been immensely discussed at international and regional fora during the past decades to secure the sustainable use of resources and promote people's welfare and equitable benefit to stakeholders involved in fishery-related activities. As a result, a number of global policy frameworks and instruments including market-driven measures had been agreed upon and applied by relevant organizations and/or importing countries. The Project **"Assistance for Capacity Development in the Region to Address International Fisheries-related Issues,"** which is being implemented by the SEAFDEC Secretariat aims to help in monitoring the emerging international fish trade-related issues and requirements, and subsequently enhance the understanding and capacity of the ASEAN–SEAFDEC Member Countries in addressing such issues. Furthermore, the Project also aims to facilitate the development of common views among the countries, and to make sure that such views and the Southeast Asian region's specificity, especially with respect to the region's fishery sector, is reflected during the discussions at appropriate regional and international fora.

In 2020, despite the unusual situation brought about by the onslaught of the coronavirus (COVID-19) pandemic resulting in the postponement of several regional and international events on international fisheries-related issues or changing the mode of communications into an online platform, SEAFDEC continued to participate and provide technical inputs at various relevant international fisheries-related fora that have implications in the development of the fisheries of the region. This included the "Virtual Dialogues on the Path to the Thirty-fourth Session of the FAO Committee on Fisheries" which was organized by FAO on 15–17 July 2020. The Project also played the role of coordinating with the ASEAN Secretariat, especially relaying to the ASEAN mechanism the progress of work made by SEAFDEC in line with the priority and policy frameworks endorsed by the AMSs and submitting for endorsement, the policy documents developed through SEAFDEC initiatives. Moreover, SEAFDEC also joined several fisheries-related meetings organized by the ASEAN in 2020 through online platforms, *i.e.* the Twelfth Meeting of the ASEAN Fisheries Consultative Forum (12AFCF) on 23 June 2020 and the Twenty-eighth Meeting of the ASEAN Sectoral Working Group on Fisheries (28ASWGFi) on 24 June 2020. During these meetings, the progress made by SEAFDEC in the implementation of the ASEAN fisheries-related policies had been reported, while the policy document developed by SEAFDEC in collaboration with the AMSs, particularly the Resolution and Plan of Action for Sustainable Fisheries' for Food Security for the ASEAN Region Towards 2030, was endorsed for submission to the higher authorities of the ASEAN. Subsequently, the Resolution and Plan of Action was adopted by the ASEAN Senior Officials and Ministers during the Special Senior Officials' Meeting of the Forty-first Meeting of the ASEAN Ministers on Agriculture and Forestry on 5 August 2020, and by the Forty-second Meeting of the ASEAN Ministers on Agriculture and Forestry on 21 October 2020.

The 12AFCF and 28ASWGFi Meetings organized via *online platform where the progress made by SEAFDEC in the implementation of ASEAN fisheries-related policies had been reported*

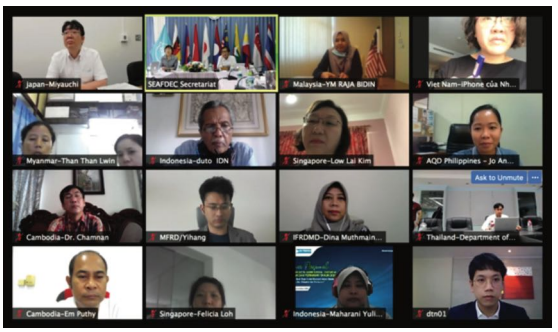
Also in 2020, SEAFDEC organized a series of webinar with the objective of enhancing the awareness and obtaining the views from the AMSs and relevant organizations/agencies on important international fisheries-related issues. One of the important issues raised during the discussions was regarding the impacts and mitigation of the impacts of coronavirus or COVID-19 on the fisheries and aquaculture sectors of the Southeast Asian countries. In order to address such concern, the SEAFDEC Secretariat organized the "Webinar on Impact of COVID-19 on Fisheries and Aquaculture in Southeast Asia" on 2–3 July 2020 that brought together experts from international, regional and national fisheries agencies, and industry representatives to discuss the key impacts of the pandemic on the region's food supply chain of fish and fishery products from the perspective of the local, national, regional, and international trade.

SEAFDEC Webinar on the Impacts of COVID-19 on Fisheries and Aquaculture in Southeast Asia organized on 2–3 July 2020

Along the line with the issues discussed at the Webinar, the SEAFDEC Secretariat also developed a Concept Proposal to conduct a more in-depth study on the "Impacts of COVID-2019 Pandemic on the Fisheries Sector of the ASEAN–SEAFDEC Member Countries" to facilitate the sharing of information and experiences among the ASEAN–SEAFDEC Member Countries. To kick off this study, SEAFDEC organized the "Inter-Departmental Workshop on Study on Impacts from Corona Virus-2019 Pandemic on Fisheries Sector of the SEAFDEC Member Countries" on 7 October 2020 to discuss the contents of the questionnaire and its objective of gathering the relevant information from the perspective of the different fisheries sub-sectors. During the Forty-third PCM and the Twenty-third FCG/ASSP Meeting in November 2020, the Concept Proposal for the Study which would be carried out in 2021, was endorsed.

Inter-Departmental Workshop on Study on Impacts from Corona Virus-2019 Pandemic on Fisheries Sector of the SEAFDEC Member Countries, on 7 October 2020

Another important international fisheries-related issue discussed in 2020 was on fisheries subsidies, which has long been negotiated under the World Trade Organization (WTO) fora. Considering that the legal text of the fisheries subsidies agreement would soon be finalized under the WTO, the SEAFDEC Secretariat organized the "Webinar on Fisheries Subsidies: Southeast Asian Region Perspectives" on 23–24 September 2020 through online platform in order to facilitate the sharing of information and concerns among the SEAFDEC Member Countries on the fisheries subsidies agreement and for the countries to gain better understanding of the negotiation agenda on fisheries subsidies. While the current discussion of the draft text of the fisheries subsidies agreement is generally aimed toward prohibition of subsidies to IUU fishing, to overfished stocks, and to overcapacity and overfishing; the issue that the AMSs could encounter in future implementation of the agreement could be the capacity of the countries to obtain information on the status of the fishery resources/stocks, especially for small-scale fisheries targeting the multi-species fishery resources. One of the suggestions made during the Webinar was for SEAFDEC to seek the assistance of FAO for supporting the regional efforts on capacity building and the development of appropriate models that could be applied to multi-species fish stock assessment in the future.



Webinar on Fisheries Subsidies: Southeast Asian Region Perspectives on 23–24 September 2020

5.2 Recognition of the importance of gender equality in the fisheries and aquaculture sector

Gender is recognized as one of the very important issues that need to be addressed in many workplaces including in the fisheries sector. Especially in small-scale fisheries in the Southeast Asian region, women and men are found to be working together in undertaking different roles and activities to support their livelihood. The "FAO Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication," or the "SSF Guidelines" therefore recommends that gender mainstreaming should be an integral part of all small-scale fisheries development strategies, considering different cultural contexts.

Gender Dimension in the Value Chain of Small-scale Fisheries and Aquaculture in Southeast Asia

Along the lines of the implementation of the SSF Guidelines, FAO agreed to support SEAFDEC/TD in the implementation of the Project **"Gender Dimension in the Value Chain of Small-scale Fisheries and Aquaculture in Southeast Asia"** in order to improve and strengthen gender dimension in selected small-scale fisheries and aquaculture values chain in Southeast Asia. Comprising four main activities, namely: 1) Conduct of site training for enumerators on gender concept and analysis, and development of a data collection protocols; 2) Collection and analysis of data on Gender Dimension in the Value Chain of Small-scale Fisheries; 3) Conduct of data validation workshops to recheck the results of data analysis with all stakeholders; and 4) Preparation of project report on gender analysis and communication products, the Project is being promoted through the conduct of regional and national workshops, as well as on-site human resource capacity building to promote gender in fisheries for Southeast Asia. The four participating countries for this Project, which is implemented from 1 January 2020 to 30 June 2021, are: Lao PDR, Myanmar, Philippines, and Thailand. However, due to the COVID-19 pandemic situation, TD was able to conduct the activities in 2020 mainly in Surat Thani Province of Thailand and Bolikhamxay Province of Lao PDR.

For Thailand, the first activity was the "Site Training for Enumerators on Gender Concept and Analysis, and Development of a Data Collection Protocol" conducted on 25–27 August 2020 in Surat Thani Province. The thirteen participants from the Department of Fisheries in Surat Thani Province, were briefed on Gender Concepts, Gender in Fisheries and Aquaculture, Gender Analysis, Gender in the FAO SSF Guidelines, and the SEAFDEC Practical Guide for Gender Analysis in Small-scale Fisheries and Aquaculture in Southeast Asia. During the training, the questionnaire for the study on Gender Dimension in the Value Chain of Small-scale Marine Aquaculture in Surat Thani was developed based on the Practical Guide, and was subjected for data collection trials. Subsequently, data collection on gender in small-scale marine aquaculture was conducted in Surat Thani Province from 28 August to 1 September 2020 followed by data validation workshop during 2–3 September 2020 to discuss the results of data collection with relevant stakeholders and to recheck the collected data, and confirm the information collected from the project site.

Site training for enumerators on gender concept and analysis, and development of data collection protocol (Surat Thani Province, 25 to 27 August 2020)

Collection of data for gender study in Surat Thani Province, Thailand from 28 August to 1 September 2020

Data validation workshop to report results of data collection for stakeholders to recheck and confirm the information from Surat Thani Province

For Lao PDR and with the collaboration of the Department of Livestock and Fisheries (DLF) of Lao PDR, TD conducted the "Site Training for Enumerator on Gender Concept and Analysis and Development of a Data Collection Protocol" from 15 to 17 December 2020 in Bolikhamxay Province. The training aimed to introduce gender concept and gender in fisheries and aquaculture to the DLF officers and develop tools for data collection in Bolikhamxay Province as the project site representing inland aquaculture. The 16 participants in this Training from the DLF comprised 8 women and 8 men. The topics for the training were: 1) Introduction on gender concept and analysis; 2) Formulation of questionnaire for

Site Training for Enumerators on Gender Concept and Analysis and Development of a Data Collection Protocol organized from 15 to 17 December 2020 in Bolikhamxay Province, Lao PDR

gender analysis in small-scale inland aquaculture; and 3) Practice of data collection at the project site. The training was carried out with active participation and information sharing among the DLF staff, while the staff from TD provided online supervision for the training.

6. Strategy VI: Empowering SEAFDEC to strengthen its roles in the region and to improve its services to Member Countries

6.1 Extending Support and Capacity for Member Countries on Fishery Resource Surveys

Fisheries Resource Survey and Operational Plan for M.V. SEAFDEC 2

The M.V. SEAFDEC 2 has been utilized by TD since 2004 to support the Southeast Asian countries in conducting fishery resource surveys for better understanding of the marine fishery resources in their respective waters. This had been facilitated through the on-going Project of TD **"Fisheries Resource Survey and Operational Plan for M.V. SEAFDEC 2"** since 2004 until 2020. Due to the onslaught of COVID-19, only Cruise No. 61-1/2020 was successfully operated on 15–18 September 2020. This cruise was a sea trial to check the main engine, generator engines, machinery, engine control system, steering gear, navigation equipment, safety device system, and bottom trawl of the M.V. SEAFDEC 2. During the sea trial, the newly installed instruments onboard the M.V. SEAFDEC 2, acquired with support from the Japan International Cooperation Agency (JICA), *e.g.* navigation and communication equipment, were operated and tested. Specifically, testing of the ship stabilizer and engine efficiency, as well as engine control system was conducted, while the load of freezing room, cold storage and refrigeration system were tried and set off. Through this sea trial, the engineers of the M.V. SEAFDEC 2 had acquired the skills and experiences on maintenance of the main engine, auxiliary engine, and deck machineries. The conditions of the navigation, engine, and trawl fishing system onboard the M.V. SEAFDEC 2 were recorded as reference for further improvement in the future. Nevertheless, through this activity, it was uncovered that sampling gears for marine debris and microplastics need to be improved, while the deck area which was installed with auxiliary boom to support operation of these sampling gears also needs modification. Furthermore, this sea trial was also used as an opportunity to demonstrate the measures and ship rules to prevent the COVID-19 outbreaks onboard fishing vessels, and applied by all the staff members who participated in the cruise. Similar measures would be applied for other surveys to be undertaken in Thailand, although undertaking research cruises outside the waters of Thailand might be difficult until the COVID-19 situation has improved.

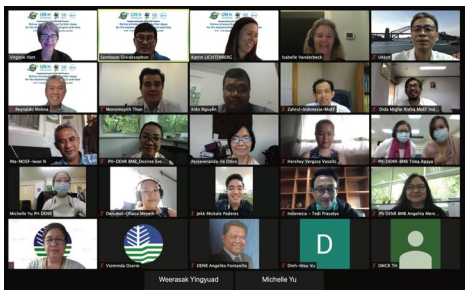
As a consequence of the COVID-19 pandemic, three research cruises planned by TD in 2020 using the M.V. SEAFDEC 2, were postponed. These include: 1) National Research Survey on Demersal Resources in the Waters of Viet Nam (expected 69 service days); 2) Marine Fisheries Resources and Marine Debris Research Survey in the Gulf of Thailand (expected 47 service days); and 3) Research cruises to compare the catch per unit effort of fishery resources by trawling between the research vessel of TD and those of the Department of Fisheries of Thailand (expected 6 service days).

6.2 Supporting Member Countries in the Implementation of Strategic Action Programme for the South China Sea and Gulf of Thailand

Implementing the Strategic Action Programme for the South China Sea and Gulf of Thailand

As early as January 2018, SEAFDEC and the United Nations Environment Programme (UNEP) signed the Project Cooperation Agreement (PCA) for SEAFDEC to serve as the "Executing Agency" for **"Implementing the Strategic Action Programme for the South China Sea and Gulf of Thailand"** or the SCS SAP Project. Funded by the UNEP-GEF and co-executed by the United Nations Office for Project Services (UNOPS) and SEAFDEC, with six participating countries, namely: Cambodia, China, Indonesia, Philippines, Thailand, and Viet Nam, the Project has the objective of providing assistance to the countries in meeting the targets of the approved Strategic Action Program (SAP) for the marine and coastal environment of the South China Sea (SCS) through implementation of the National Action Plans in support of the SAP, and strengthening regional coordination for SCS SAP implementation. The Project has three components, namely: 1) Reducing habitat degradation and loss *via* national and local reforms to achieve Strategic Action Programme targets for coastal habitat management in the South China Sea; 2) Strengthening knowledge-based action planning for the management of coastal habitats and land-based pollution to reduce environmental degradation of the South China Sea; and 3) Facilitating regional and national level integration and cooperation for implementation of the South China Sea Strategic Action Programme.

The original period of the Project was from January 2018 until June 2023, but after the signing of the PCA, the Project implementation encountered some initial delays until recently when the Project implementation finally took off with the Project Inception Phase in 2020. In order to launch the Project's Inception Phase, the "First Regional Inception Phase Meeting" was organized by UNEP on 30 July 2020 through an online platform. Following the meeting, the project national teams organized their respective internal coordination and consultations with concerned agencies and institutions to discuss the project and inception phase activities. This includes review and confirmation of national focal points of different project bodies including memberships, review and confirmation of intervention sites, and review and updating of the draft National Implementation Report to include activities, workplan and budget. At the regional level, the project organized bilateral meetings with national teams to guide and provide details of the inception phase activities.



Participants of the First Regional Inception Phase Meeting (30 July 2020)

Participants of the Second Regional Inception Phase Meeting (4 December 2020)

The "Second Regional Inception Phase Meeting" was subsequently organized on 4 December 2020 also through an online platform. The Meeting was updated on the progress towards elaborating the SCS SAP Inception Reports, while a review of the workplan, current budget and status of national activities, was also carried out.

The Project is expected to come up with 2020 National Implementation Report of the respective countries, as well as the Regional Implementation Report detailing the achievements of the activities based on the work plan in 2020. Such outputs would serve as basis for the subsequent Project Implementation Phase which is expected to commence during the second quarter of 2021. As the SCS SAP Project is co-executed by SEAFDEC and UNOPS, UNOPS is responsible for national contract, staff and consultants; while SEAFDEC is responsible for the project office, regional contract, meetings, training and conferences. The Project Coordinating Unit (PCU) established at the SEAFDEC/TD premises is responsible for the day-to-day management and execution of activities, reporting, among others, on behalf and under the guidance of SEAFDEC and UNOPS.

6.3 Enhancing human resources within the SEAFDEC organization

SEAFDEC Capacity Development through USAID Sustainable Fish Asia Activity

SEAFDEC has partnered with the United States Agency for International Development Regional Development Mission for Asia (USAID/RDMA) for the two-year **"Sustainable Fish Asia (SUFIA)"** Project aimed at improving the management of marine biodiversity and fishery resources in the Southeast Asia and Pacific regions by reducing unsustainable and IUU fishing. Implemented by the Research Triangle Institute (RTI) International, the Project which was embarked during the last quarter of 2020, has engaged SEAFDEC and the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF) as partners, under the Project's two Tasks, namely: Task 1 – organizational capacity assessment (OCA) and customized capacity development services for SEAFDEC and CTI-CFF; and Task 2 – private sector landscape assessment (PSLA) to identify opportunities for collaboration with private sector within the fisheries industry in the region.

For the activities undertaken in collaboration with SEAFDEC under Task 2, initial desk research and consultations were undertaken by RTI and SEAFDEC to explore the relevant areas of works where private sector engagement could be enhanced. On 18 December 2020, some staff from SUFIA and USAID/RDMA visited SEAFDEC/TD in Samut Prakan to introduce the SUFIA team, meet with TD staff, familiarize with the organizational structure of TD, tour the grounds, and visit the SUFIA office. Subsequently, on 23 December 2020, representatives of SUFIA and TD visited Baan Nainang Village in Krabi Province, Thailand and discussed with staff of the DOF Thailand and local stakeholders, such as the Bee Sub-Group, on their social enterprise model, its contribution to marine conservation, generation of additional income for fishers, and the challenges encountered during their operations. The visit also provided valuable information for a potential private sector engagement opportunity for the Project.

Visit of representatives from SUFIA and USAID/RDMA at SEAFDEC Training Department on 18 December 2020

Representatives from SUFIA, SEAFDEC, and the DOF Thailand discussing with representatives of the "Bee Sub-Group" *on 23 December 2020 at Baan Nainang Village in Krabi Province, Thailand*

In parallel with the activities under Task 2, the "Inception Meeting for Organizational Capacity Assessment" was organized at the SEAFDEC Secretariat on 9 December 2020, which was meant to review the organizational management of SEAFDEC for handling direct project grants from the USAID in the future. The Meeting, which was attended by the Secretary General of SEAFDEC, and other relevant officers of the SEAFDEC Secretariat and Training Department, SUFIA RTI team, and USAID RDMA, discussed and agreed on the process and plan for a participatory local organizational capacity assessment (PLOCA), as part of the activities under Task 1.

SUFIA and SEAFDEC held the Capacity Assessment Inception Meeting (9 December 2020 at SEAFDEC Secretariat)

SEAFDEC PROGRAMS FOR 2021

During the Forty-third Meeting of the SEAFDEC Program Committee (10–12 November 2020, online meeting), the programs and projects to be implemented by SEAFDEC in 2021 were scrutinized and endorsed. These programs/projects had been categorized as: 1) Projects under the Fisheries Consultative Group of the ASEAN–SEAFDEC Strategic Partnership (FCG/ASSP) Mechanism (16 on-going and 3 new projects); 2) Departmental Programs (10 programs); and 3) Other Programs (4 programs). The list and description of programs and projects in 2021 appears as follow:

Strategy/Project Title	Lead Department	Funding Source
Strategy I: Securing the sustainability of fisheries to contribute to food security, poverty alleviation and livelihood of people in the region		
1. Strengthening a Regional Cooperation and Enhancing National Capacities to Eliminate IUU Fishing in Southeast Asia (*2020–2024*) Starting from 2020, the Project continued to promote the regional tools that had been developed by TD in combating IUU fishing under the Project "Promotion of Countermeasures to reduce IUU Fishing" which was completed in 2019. These tools include the Database on Regional Fishing Vessels Record (RFVR), enhanced regional cooperation to support the implementation of Port State Measures (PSM), and the electronic ASEAN Catch Documentation Scheme (eACDS) with a view to prevent the entry of fish and fishery products from IUU fishing into the supply chain. In 2021, the Project would continue to explore the ways forward for the RFVR as well as other tools for combating IUU fishing, including the possibility of expanding the RFVR Database to include vessels less than 24 meters in length. Capacity building on PSM in the AMSs would be sustained while expansion of the eACDS application would be continued in Brunei Darussalam, Viet Nam, Malaysia, Myanmar and Cambodia.	TD	JTF
2. Harmonization and Enhancing Utilization of Fishery Statistics and Information (*2020–2024*) The Project has the overall objective of enhancing the utilization of fishery statistics data and information for policy planning and management of fisheries toward sustainability. Under this Project, concerned staff from SEAFDEC will continue to participate in international meetings related to fishery statistics. As the Regional Technical Consultation scheduled in 2020 to discuss among the AMSs on the need to review/revise the Regional Framework for Fishery Statistics of Southeast Asia was postponed due to the COVID-19 pandemic, the Consultation	SEC	JTF

Strategy/Project Title	Lead Department	Funding Source
will be conducted in 2021 instead. Moreover, on the production of the publication "Southeast Asian State of Fisheries and Aquaculture 2022" or SEASOFIA 2022, the contents of the publication would be prepared by the respective Departments and compiled by the Secretariat. Meanwhile, the publication "Fish for the People" Volume, 19 with 3 issues annually would be sustained under this Project.		
3. Responsible Fishing Technology and Practice (*2020–2024*) The Project aims to promote responsible fishing technologies and practices in Southeast Asia that minimize the impacts of fishing activities on the fishery resources and the marine ecosystems. In 2021, TD planned to undertake research on the specific fishing gear selectivity, and conduct desk study on the preliminary investigation to estimate the Abandoned, Lost and Discarded Fishing Gears (ALDFG) focusing on traps (pots) and gillnets along the coasts of Thailand. Online seminars and workshops would be conducted to enhance knowledge and awareness of participants from the AMSs on fishing technology, while the results from the activities would be published and disseminated. Furthermore, TD will continue to improve appropriate techniques to manage fuel consumption, carbon emission, and/or safety in fishing operation. The new M.V. PLALUNG, which was modified and equipped with new deck machineries, hauling device, and refrigerating system, would be mobilized to provide human resource development for the AMSs.	TD	JTF
4. Research for Enhancement of Sustainable Utilization and Management of Sharks and Rays in the Southeast Asian Region (*2020–2024*) The Project aims to work toward capacity development for the participating Member Countries, namely: Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Thailand, and Viet Nam, on taxonomy, new species/record identification, and management of major shark species; confirmation of stock structures for selected common species and CITES-listed species of sharks and rays; and development of socio-economic studies in selected sites using multifactor partitioning analysis. In 2021, MFRDMD would conduct an on-site training on taxonomy and biology in Viet Nam; and a training workshop on shark stock assessment models, *e.g.* Bayesian Surplus Production model and Bayesian State Space Surplus Production Model. TD and MFRDMD would continue to support landing data collection at Tawau and Kota Kinabalu	MFRDMD	JTF

Strategy/Project Title	Lead Department	Funding Source
in Sabah, Malaysia. Furthermore, this project would also continue to study the stock structures of two shark species (*Chiloscyllium hasseltii* and *Carcharhinus sorrah*) and one CITES-listed species (*Sphyrna lewini*); and conduct a survey on fishers' dependencies, marketing and trade of sharks and rays at Pontianak in Indonesia.		
5. Sustainable Utilization of Anguillid Eels in the Southeast Asian Region (*2020–2024*) The Project aims to support the sustainable management and utilization of anguillid eel fishery resources in the Southeast Asian region through the strategic program on sustainable eel resources management. In achieving sustainable eel fisheries and standardization of data collection system in Southeast Asia, surveys would be conducted in Indonesia and Philippines to collect catch and effort data as well as biological data. On genetic population structure of tropical eels in Southeast Asia, tissue samples would be collected in Indonesia, as well as in other countries, such as Philippines, Viet Nam and Myanmar. Laboratory work would also be conducted to analyze the genetic population structure of tropical anguillid eels. In 2021, IFRDMD would continue the survey to collect catch and biological data, which could not be undertaken in 2020 due to the COVID-19 pandemic. Genetic survey would also be continued to identify the genetic population structure of tropical anguillid eels in Southeast Asia using a mtDNA marker. Samples and/or tissues of *Anguilla marmorata* to be collected from Indonesia, Philippines, and Viet Nam, would be analyzed. Furthermore, IFRDMD would also conduct two progress meetings in 2021, and a study to evaluate the project achievement at the end of 2021.	IFRDMD	JTF
6. Sustainable Utilization of Fisheries Resources and Resources Enhancement in Southeast Asia (*2020–2024*) The Project aims to achieve improved technical capacities of human resources in the region in conducting marine fishery resources and oceanographic research surveys; improve technical knowledge, skills and experiences of staff from SEAFDEC and the Member Countries through their participation in survey cruises; assist in the development of research cruise plans for the vessels of SEAFDEC and those of the Member Countries; generate scientific knowledge to support the management of transboundary fishery resources in Southeast Asia; promote the application of Fisheries GIS (FGIS) and Remote Sensing (RS) for monitoring the marine	TD	JTF

Strategy/Project Title	Lead Department	Funding Source
fishery resources and the environment; and sustain resource enhancement through establishment of artificial habitats. In 2021, TD would continue to support capacity building for researchers from the participating AMSs on: marine debris and microplastic surveys and analysis; application of FGIS and RS for monitoring the fishery resources and the environment; and fishery resources enhancement. Researchers from the AMSs would also be supported to participate in onboard survey(s).		
7. Fisheries Management Strategies for Pelagic Fish Resources in the Southeast Asian Region (*2020–2024*) With the participating countries, namely: Brunei Darussalam, Cambodia, Indonesia, Malaysia Myanmar, Philippines, Thailand, and Viet Nam, the Project would support stock and risk assessments for small pelagic fisheries, especially neritic tunas in the Southeast Asian region; clarify the stock structure for neritic tuna species in the region; and carry out life history study for neritic tuna species in the region. To support the conduct of regional studies on stock and risk assessments of shared stocks in the region, MFRDMD would continue to collaborate with the participating AMSs and relevant organizations in 2021 to gather comprehensive and reliable information on catch and effort of targeted small pelagic fishes (*Rastrelliger kanagurta*, *R. brachysoma*, *Decapterus* spp.), and neritic tunas (*Thunnus tonggol* and *Euthynnus affinis*). MFRDMD would also continue the study on the clarification of the genetic structure of kawakawa as well as develop its life history through age determination analysis (otolith analysis). A regional workshop would be organized to discuss and update the current status of two neritic tuna species in the South China Sea and Andaman Sea as well as to share the progress of genetic study for *Euthynnus affinis*.	MFRDMD	JTF
8. Management Scheme for Inland Fisheries in the Southeast Asian Region (*2020–2024*) In achieving the objectives toward the sustainable management and utilization of inland fishery resources in Southeast Asia, the Project would carry out two main activities, namely: 1) development and dissemination of the guidelines on inland fisheries management in Southeast Asia in order to improve the fishers' livelihoods; and 2) establishment of catch database and profiles of freshwater fish biodiversity, and publication of the manual book on collection and sampling of inland fish biological characteristics. In 2021, Myanmar and Thailand	IFRDMD	JTF

Strategy/Project Title	Lead Department	Funding Source
were selected as the pilot sites for the implementation of these activities by IFRDMD.		
9. Small-scale Fisheries Management for Better Livelihood and Fisheries Resources (*2020–2024*) The Project aims toward the sustainable management of small-scale fisheries (SSF) for improving the livelihood and well-being of fishers in Southeast Asia. In 2021, TD would organize a regional training course on EAFM management tools, and continue to collaborate with Thailand and Myanmar in the implementation of the transboundary EAFM in Ranong-Koh Song, as well as with Cambodia and FAO in the implementation of inland EAFM in Boeng Tonle Chhmar in the northern part of Tonle Sap Great Lake. TD also planned to review the implementation of EAFM at the learning sites in Myanmar, Thailand and Cambodia through a questionnaire survey. Furthermore, TD would also conduct a study in selected AMSs on the status of fishery socio-economic assistance, particularly in microfinancing, credit and insurance in line with the SSF guidelines, as well as a regional workshop to strengthen knowledge of the topics related to livelihood and well-being of small-scale fishers, and a regional training/workshop on gender in fisheries.	TD	JTF
10. Establishment and Operation of a Regional System of Fisheries *Refugia* in the South China Sea and Gulf of Thailand (*2016–2020, extended to June 2023*) Implemented in six participating countries, namely: Cambodia, Indonesia, Malaysia, Philippines, Thailand, and Viet Nam, the Project aims to "operate and expand the network of fisheries *refugia* in the South China Sea and the Gulf of Thailand for improved management fisheries and critical marine habitats linkage." Originally, this project was scheduled to be completed in December 2020, however, considering that several activities could not be undertaken in 2020 due to the COVID-19 pandemic, the project' duration was extended until June 2023.	TD	UNEP/ GEF
11. Strengthening the Effective Management of Inland Fisheries and Aquaculture in AMS with GIS and RS Technology (*2019–2020, extended to 2021*) This project was implemented since 2019 in participating countries, namely: Cambodia, Indonesia, Lao PDR, Myanmar, and Thailand, with the objectives of contributing to the effective management of inland fisheries and aquaculture in	SEC in collaboration with TD	JAIF

Strategy/Project Title	Lead Department	Funding Source
the AMSs through the use of GIS Mapping/RS technology. This project was originally scheduled to be completed in June 2020; however, considering that several activities could not be completed due to the COVID-19 pandemic, the project's duration was extended until December 2021. Activities in 2021 would focus on verification and analysis of data collected by enumerators in the participating countries, and development of a technical manual on analytical methods using GIS/RS techniques to understand the relationship between environmental data and the amount of catch. The project would also conduct a workshop to discuss on the use of GIS/RS technology and analytical methods, and the project-end-meeting to present the findings from this project to the AMSs for further application.		
12. Development of Stock Assessment Methods and Strengthening of Resources Management Measures for Tropical Anguillid Eel in Southeast Asia (*2020–2021*) The project which started in 2020, focused on collection of catch data and biological/ecological information for the estimation of eel resources stocks, and development of mathematical/statistical methods for estimating tropical anguillid eel resources stocks that could be used for the formulation of effective management measures for the sustainable use of tropical anguillid eels in Southeast Asia. In 2021, IFRDMD would continue the activities to establish the system for collection of statistical data on catch and aquaculture of tropical anguillid eels, and conduct of eel statistical survey to collect and analyze data from four target countries, namely: Indonesia, Myanmar, Philippines, and Viet Nam. Specifically, data on eel catch and fishing effort, and biological data would be collected from two sites in Indonesia to assess eel stocks, while genetic data would be collected from eel habitats in Indonesia, Myanmar, Philippines, and Viet Nam, and analyzed to clarify the genetic structure of the eel populations in Southeast Asia.	SEC in collaboration with IFRDMD	JAIF
13. ASEAN–JICA Cooperation for Capacity Building on IUU Fishing Countermeasures in Southeast Asia (*new project, 2021–2024*) This project is aimed at enhancing the capacities of the AMSs to prevent and combat IUU fishing through a series of training and/or workshop activities for staff of relevant government agencies in the implementation of activities to eliminate IUU fishing. In 2021, TD would organize a Regional	TD	JICA

Strategy/Project Title	Lead Department	Funding Source
Training Course on Electronic ASEAN Catch Documentation Scheme (eACDS) in Southeast Asia, aimed at promoting traceability of fishery products for combating IUU fishing in the region. Subsequently, on-site training sessions on eACDS would be conducted in three pilot sites (selected from Brunei Darussalam, Cambodia, Malaysia, Myanmar or Viet Nam). Furthermore, a Regional Capacity Building Workshop on Enhancing Policies and Countermeasures Against IUU Fishing in Southeast Asia would also be conducted.		
14. Regional Collaborative Research and Capacity Building for Monitoring and Reduction of Marine Debris from Fisheries in Southeast Asia (*new project, 2021–2022*) The project has the overall objectives of enhancing regional collaborative research and capacity building in the fisheries sector, including application of scientific knowledge in regional policies and monitoring based on four priority areas of the "ASEAN Framework of Action on Marine Debris." The activities under this project include: Information gathering to estimate the amount of ALDFG and monitoring of ALDFG at accumulated pilot sites and development of removal guidance of ALDFG; Conduct of workshop for information exchange and development of technical guidance on ALDFG countermeasures; Conduct of marine environment and fishery resources survey using a research vessel, and evaluate the impacts of microplastics on the fishery resources (in the Gulf of Thailand); Research and evaluation on amount of marine debris collected by different types of fishing gears during the fishing activities at sea; Investigation and risk assessment of microplastics in freshwater fish and marine fish, and dissemination of the results on contaminants of microplastics (pilot sites: in the Gulf of Thailand (for marine fish) and at Musi River, South Sumatra, Indonesia (for freshwater fish)); On-the-job training on reliable research methods on marine debris and microplastics to officers and researchers in the AMSs; Conduct of Regional Symposium on Marine Debris and Microplastics in Fisheries in Southeast Asia; Development of the project website and communication materials; and Development of technical manual for marking of fishing gears.	SEC in collaboration with TD, MFRDMD, and IFRDMD	JAIF

Strategy/Project Title	Lead Department	Funding Source
Strategy II: Supporting the sustainable growth of aquaculture to complement fisheries and contribute to food security, poverty alleviation and livelihood of people in the region		
15. Sustainable Aquaculture through Cost-Effective Culture Systems, and Prompt and Effective Aquatic Animal Health Management (*2020–2024*) The Project aims to attain sustainable aquaculture through cost-effective culture systems, and prompt and effective aquatic animal health management schemes. Various related activities to be implemented by AQD are in line with this goal. In 2021, the activities include: 1) Conduct of more hands-on training on giant freshwater prawn hatchery, nursery and grow-out operations; 2) Experiments on the utilization of aquatic weeds and fishery by-products to replace soybean and fishmeal in diets for tilapia in biofloc-based systems; 3) Design of artificial or constructed wetlands, and investigation of its efficiency in mitigating the effects of diseases using mesocosms; 4) Continuation of active surveillance, epidemiological information, distribution, occurrence and prevalence of *Enterocytozoon hepatopenaei* (EHP); 5) Development of detection methods for viral and bacterial diseases that have caused the decline of aquaculture production both in marine fish and shrimp farming; 6) Development of seed and nursery production techniques of kawakawa (*Euthynnus affinis*), shortfin scad (round scad, *Decapterus macrosoma*), flathead lobster (*Thenus orientalis*), and seahorse (*Hippocampus comes*); 7) Identification of chemicals and processes that can be used to disinfect *P. monodon* fertilized eggs and nauplii against pathogens; 8) Simulated tank trials to test the combined shrimp management approaches vs AHPND (year 2); and 9) Conduct of training courses on sustainable aquaculture (including virtual training sessions).	AQD	JTF
Strategy III: Ensuring the food safety and quality of fish and fishery products for the Southeast Asian region		
16. Enhancing Food Safety and Competitiveness of Seafood Products (*2020–2024*) The Project is aimed at improving food safety and the competitiveness of seafood products in the ASEAN region through the conduct of training workshops and development of guidelines, with support from regional technical experts. The Project comprises two scopes: 1) Development of regional standards and guidelines on Good Manufacturing	MFRD	JTF

Strategy/Project Title	Lead Department	Funding Source
and Handling Practices (GMP & GHP) for sushi and sashimi; and 2) Introduction of High-Pressure Processing (HPP). The activities in 2021 would follow the workplan agreed during the inception meeting conducted in 2020. Under the first scope of activities, MFRD will develop training materials and conduct regional training course on GMP & GHP for sushi and sashimi; while under the second scope, activities would include: R&D and product development in collaboration with local institutes and industry cooperants/partners; Development of training materials for HPP of fish and fishery products; and Preparation of handbook on HPP of fish and fishery products.		
17. ASEAN–JICA Food Value Chain Development Project (*new project, 2021–2024*) The ASEAN–JICA Food Value Chain Development Project is composed of four major thematic areas: 1) ASEAN Good Agriculture Practice (GAP); 2) Sanitary and Phyto-sanitary (SPS) measures; 3) Fishery value chain; and 4) Coordination and research on Public-Private Partnership (PPP)-based Food Value Chain. The proposed project to be implemented by SEAFDEC supports the fisheries sector by strengthening GAqP (Good Aquaculture Practice) and SPS measures. The activities to be implemented in 2021 include: 1) Training course on GAqP (Good Aquaculture Practice) in marine fish aquaculture; 2) Regional workshops for the development of eco-labeling strategy in Southeast Asia; and 3) Survey on the food safety testing for fish and fishery products to determine the specific scope of food safety testing guidelines, *e.g.* heavy metals, histamine, and organic contaminants, followed by a workshop to understand the current state, interest and capability of the identified scope of food safety testing across the ASEAN region.	SEC in collaboration with TD, AQD and MFRD	JICA
Strategy IV: Enhancing trade and compliance of the region's fish and fishery products with market requirements		
No project under this Strategy in 2021		
Strategy V: Addressing cross-cutting issues, such as labor, gender and climate change, where related to international fisheries		
18. Assistance for Capacity Development in the Region to Address International Fisheries-related Issues (*2020–2024*) The Project aims to ensure the sustainable utilization and sound management of fishery resources through	SEC	JTF

Strategy/Project Title	Lead Department	Funding Source
appropriate regional approaches in international fish trade. In 2021, SEAFDEC would continue to support its staff to participate in relevant regional/international fora, *e.g.* FAO/COFI, CITES, etc., and provide updates to the AMSs on the status of the international fish trade-related issues that may impact on the development of fisheries and aquaculture in the region through regional technical consultation(s). SEAFDEC would also conduct a "Study on Impacts of COVID-19 Pandemic on the Fisheries Sector of ASEAN–SEAFDEC Member Countries." Moreover, a meeting would be organized to set-up a common system/ methodology to monitor the implementation and evaluate the implementation of regional guidelines adopted by the SEAFDEC Council and high-level authorities of ASEAN. While SEAFDEC also planned to continue supporting and strengthening its cooperation with the AMSs through the Regional Fisheries Policy Networks (RFPNs), although the activities would be subject to the COVID-19 situation.		
Strategy VI: Empowering SEAFDEC to strengthen its roles in the region and to improve its services to Member Countries		
19. Fisheries Resource Survey & Operational Plan for M.V. SEAFDEC 2 (*since 2004*) The M.V. SEAFDEC 2 was granted by the Government of Japan in 2004 to support the Member Countries' fishery resources and marine environmental surveys. Under the agreed cost-sharing scheme, technical support to the Member Countries has been sustained by TD for monitoring of their respective fishery resources and marine environmental conditions, and enhancing human resource development. In 2021, TD would avail of the services of the M.V. SEAFDEC 2 for the following activities: 1) National fishery research surveys, *i.e.* hydro-acoustic survey in Philippine waters (as requested during the 43PCM); 2) Marine fishery resources, environment and marine debris research survey in the Gulf of Thailand; and 3) Comparison on the Catch Per Unit Effort of fishery resources by trawling between research vessels of TD and the DOF Thailand. However, implementation of these activities would be subject to the COVID-19 situation in 2021.	TD	JTF, with cost sharing from AMSs requesting to use the vessel

2) Departmental Programs

Program Title	Department	Funding Source
1. Quality Seed for Sustainable Aquaculture The Program aims to generate, verify, and promote technologies to ensure the sustainable production of quality seed stocks for aquaculture and for stock enhancement. In 2021, the Program would continue to undertake the following: • Verification studies on breeding and seed production of giant and hybrid groupers (*Epinephelus* spp.) • Verification of the effectiveness of SEAFDEC/AQD broodstock diets in improving the reproductive performance in tropical abalone, *Haliotis asinina* • Economic viability of tank-based polychaete culture technology • Use of biofloc system to improve water quality, growth performance and disease resistance of *Penaeus monodon* and *Penaeus indicus* juveniles reared in tanks • Use of algal paste in the larval rearing of mangrove crab *Scylla serrata* • Optimizing hatchery production of early juvenile sandfish *Holothuria scabra* • Development of techniques for sustainable mass production of harpacticoid copepods for marine fish and crustacean larviculture • Utilization of artificial illumination in floating net cages on the nursery culture of pompano *Trachinotus blochii*: Effects on the growth and survival of pompano and its added economic value • Production of farmed eucheumatoids by micropropagation in land-based nursery • Optimizing the survival of micropropagated seaweed *Kappaphycus alvarezii* through acclimation in tank-based nursery systems • Sea-based nursery cage production of farmed eucheumatoids • Optimization of electrolytic flocculator for paste production of important locally available microalgae in aquaculture • Development of a modified continuous culture system for the mass production of *Nanochlorum* sp. and *Brachionus rotundiformis* • Seed production of donkey's ear abalone *Haliotis asinina* juveniles	AQD	AQD*

Program Title	Department	Funding Source
• Seed production of mangrove crab with refinements on the feeding frequency • Study on the Anguillid eels (population genetics and e-DNA research)		
2. Healthy and Wholesome Aquaculture The Program has two main components: 1) Fish Health; and 2) Nutrition and Feed. The Fish Health Component aims to improve aquaculture production through innovations in aquaculture nutrition and feeding, and fish health management, as well as in maintaining the environmental integrity of aquaculture systems. The activities in 2021 would include: • Detection, quantification, and viability of Tilapia Lake Virus (TiLV) in pond soil and water as influenced by water quality parameters and culture management • Efficacy of different therapeutants against *Caligus* sp. infestation in tropical fish under laboratory conditions • Detection, control, and treatment of persistent and emerging pathogens affecting pond cultured Asian catfish (*Clarias macrocephalus*) • Field verification of the vaccination regimen in cage-cultured marine fish species (pompano, snapper, grouper) broodfish at Igang Marine Station as a practical strategy to prevent the vertical transmission of nervous necrosis virus during seed production • Use of biofloc system to improve water quality, growth performance, and disease resistance of *Penaeus monodon* and *Penaeus indicus* juveniles reared in tanks • Safeguarding the future of the Seaweed Industry of the Philippines: Disease and Pest Detection • Studies on the virulence factors of the Philippine strains of *Streptococcus* spp. and their potential application for vaccine development against streptococcal infection in tilapia and other susceptible fish species • Molecular Studies on Seaweeds • Antimicrobial resistance study on bacteria from shrimp and its environment • Epidemiological studies on persistent diseases like ice-ice in seaweeds, *Caligus* in pompano, bacterial diseases of finfishes, other diseases The Nutrition and Feed Component aims to: 1) find effective alternative protein sources to fish meal in dietary formulations;	AQD	AQD*

Program Title	Department	Funding Source
2) determine specific nutrients that enhance growth performances; and 3) promote practices and strategies to improve production. The activities in 2021 would include: • Quantitative amino acid requirements of juvenile Asian sea bass (*Lates calcarifer Bloch*): Requirements for leucine, isoleucine, and histidine • Spray dried hemoglobin (SDH) powder meal as an alternative protein source in grouper diets • Evaluation of raw meal, fermented and live green macroalgae *Chaetomorpha linum* as food source for farmed *Penaeus monodon* • Hatchery production and semi-intensive pond culture of *Penaeus* (*Fenneropenaeus*) *indicus* • Grow-out culture of abalone comparing the use of *Gracilariopsis heteroclada* and SEAFDEC formulated diet as feeds • Production techniques for culture of silver therapon (*Leiopotherapon plumbeus*) in tanks and cages • Nutritional interventions to improve reproductive performance of Indian white prawn, *Penaeus indicus* (*H. Milne Edwards, 1837*) • Test of refined formulated feed for the grow-out culture of mangrove crab, *Scylla serrata* (Forsskal) in land-based tanks		
3. Maintaining Environmental Integrity through Responsible Aquaculture The general objective of the Program is to develop environment-based aquaculture technology by integrating environmental factors in SEAFDEC/AQD research activities, and to maintain environmental integrity by promoting responsible aquaculture practices. In 2021, most of the studies undertaken in the previous year would be continued including: • Strategic feeding of milkfish (*Chanos chanos*) for efficient marine cage culture product • Increasing technical skills supporting community-based sea cucumber production in Vietnam and the Philippines • Development of optimal fish-prawn co-culture schemes in tanks and lake-based cages for increased farm production • IMTA: Demonstration and verification of sustainable and efficient aquaculture techniques by combination of multiple organisms • Grow-out culture of abalone in pipes • Polychaete culture in raceway ponds	AQD	AQD*

Program Title	Department	Funding Source
4. Meeting Social and Economic Challenges in Aquaculture The Program generally aims to implement socioeconomic research and development studies to promote the inclusive engagement of fisherfolk communities and small-holder fish farmers in aquaculture and resource enhancement. In 2021, the activities will include: • Development of community-based sustainable aquaculture livelihood strategies in Laguna Lake and tributaries • Assessment and development of community-based sandfish (*Holothuria scabra*) farming livelihood for fishing communities	AQD	AQD*
5. Adapting to Climate Change Impacts The overall goal of the Program is to help ensure the sustainability of aquaculture amidst the expected impacts of disturbances in the culture environment brought about by climate change/global warming. In 2021, the Program would continue to incorporate climate change-resilient practices in studies conducted by AQD as well as in training and information materials.	AQD	AQD*
6. Collaborative Projects with the Philippine Government With the goal of accelerating fish production and export revenues from the aquaculture sector in the Philippines, AQD is committed to intensifying techno-transfer of matured aquaculture technologies to stakeholders which will provide additional and alternative livelihood to fisherfolks through sustainable aquaculture technologies that are economically viable, environment-friendly, and socially equitable. In 2021, AQD in collaboration with the DA-BFAR, NFRDI and other government agencies, would continue strategizing to harmonize relevant research and development studies with the priorities of the host Government. The projects/activities include: • Fry sufficiency program • Development of cost-efficient feeds • Oplan Balik Sugpo (Operation Black Tiger Prawn Revival) • Accelerated Techno-Transfer • Manpower Development	AQD	AQD*

Program Title	Department	Funding Source
7. Promotion on Strengthening of SEAFDEC Visibility and Enhancing Human Capacity Building The Program has the overall objective of strengthening visibility and image of SEAFDEC, while also enhancing the knowledge and experience of relevant agencies and stakeholders on fisheries-related issues. In 2021, the activities would be categorized into: 1) Promotion and enhancement of SEAFDEC visibility and image; 2) Production of information materials, *e.g.* books, brochures, VDO, and other media, to promote awareness and understanding for fishermen, stakeholders, and the public; 3) Management information system including databases, TD website and social media; and 4) Enhancing human capacity building including conduct of tailor-made training based on needs of partners and donors.	TD	TD*
8. Improvement of Fisheries Technology and Reduction of the Impact from Fishing Activities The Program has the overall objective of improving fishing technologies and marine engineering to support the sustainable utilization of marine fishery resources. In 2021, the activities would be under three categories, namely: 1) Promotion of appropriate technologies and practices of fishing and marine engineering, including reduction of manpower in fishing operations, safety at sea, marking of fishing gear, improving fishing gear design and survey equipment, among others; 2) Study on the impacts of fishing activities on fisheries resources, marine environment, and social well-being and livelihoods of fishers; and 3) Development of database on information compiled through the fishery resources surveys, socio-economic and small-scale fisheries studies to support fisheries management.	TD	TD*
9. SEAFDEC Capacity Development through USAID Sustainable Fish Asia Activity (*2020–2021*) The "Sustainable Fish Asia (SUFIA)" project aims to improve the management of marine biodiversity and fishery resources in the Southeast Asia and Pacific regions by reducing unsustainable fishing and IUU fishing. Implemented by the Research Triangle Institute (RTI) International, and in partnership with SEAFDEC and the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF), the Project comprises two Tasks, namely: 1) Organizational capacity assessment (OCA) and customized capacity development services for SEAFDEC and CTI-CFF; and 2) private sector	TD	USAID

Program Title	Department	Funding Source
landscape assessment (PSLA) to identify opportunities for collaboration with private sector within the fishery industry in the region.		
10. Modernizing Irrigated Agriculture to Protect and Restore Aquatic Biodiversity and Ecosystem Services in South-East Asia (*2020-2021*) The aim of the project is to improve agricultural water management and irrigation practices in the Southeast Asian region to protect and restore fisheries production, aquatic biodiversity and ecosystem services. This project engaged SEAFDEC by CSU for work on the project. SEAFDEC will carry out the following project tasks as further described in the funding agreement: 1) Engage project staff as indicated in the project head agreement; including employing a project coordination officer; 2) Organize a preliminary consultation workshop involving both MMAF and Public Works staff in both Jakarta and Palembang; 3) Organize logistics for an irrigation biodiversity masterclass to be held in Palembang; 4) Contribute to the development a biodiversity master plan for the Komering Irrigation Upgrade Project; and 5) Participate in a final project collaboration workshop with key Mekong and Myanmar staff.	IFRDMD	AWP

* Funding from regular contributions of respective Host Governments

3) Other Programs

Strategy/Project Title	Lead Department	Funding Source
1. Implementing the Lower Mekong Fish Passage Initiative in Cambodia, Thailand, and Viet Nam (*2018–2020, extended to 2021*) The Project aims to build the capacity within SEAFDEC and Lower Mekong nations to construct and maintain low head fish passes to restore fisheries connectivity at irrigation facilities, weirs, and road prisms. The original plan of this Project was to construct three demonstration fish passes, one each in Cambodia, Thailand, and Viet Nam. However, the Project was extended to 2021 for the construction of three additional demonstration fish passes in Cambodia.	TD	US-DOI
2. Gender Dimension in the Value Chain of Small-scale Fisheries & Aquaculture in Southeast Asia (*2020–2021*) Implemented in five participating countries, namely: Lao PDR, Myanmar, Philippines, and Thailand, the Project has the	TD	FAO

Program Title	Department	Funding Source
objectives of: 1) Identifying gender issues and appropriate interventions in the fisheries value chain; 2) Promoting gender equality and equity in decision-making processes and organizations, fisheries technologies, and policies; and 3) Empowering men and women in small-scale fishing communities in sustaining their livelihoods. Considering that the activities in 2020 could only be undertaken in Thailand due to the COVID-19 situation, the activities in 2021 would be carried out in Lao PDR, Myanmar, and Philippines. Lessons learned from this Project would be shared with the SEAFDEC Member Countries through the project report on gender analysis and communication products, and the regional workshop to be organized in 2021.		
3. Strategic Action Programme for the South China Sea and Gulf of Thailand (*2018–2023*) Executed by the United Nations Office for Project Services (UNOPS) and SEAFDEC in six participating countries, namely: Cambodia, China, Indonesia, Philippines, Thailand and Viet Nam, the Project has the objective of assisting the countries in meeting the targets of the approved Strategic Action Program (SAP) for the marine and coastal environment of the south China Sea (SCS) through implementation of the National Action Plans in support of the SAP, and strengthening regional coordination for SCS SAP implementation. While UNOPS is responsible for national contract, staff and consultants; SEAFDEC is responsible for the project office, regional contract, meetings, training and conferences.	TD	UNEP-GEF
4. Seminar-Workshop on Aquaculture Development in Southeast Asia (ADSEA) The Seminar-Workshop on Aquaculture Development in Southeast Asia (ADSEA) was proposed to be conducted by AQD in 2021 to review the recent developments in aquaculture and provide a forum to discuss strategies to ensure further developments of responsible aquaculture in the region. It is expected that by the end of the workshop, the participants would be updated on the recent activities on sustainable and responsible aquaculture technologies, including the gaps and possible research areas. Recommendations to address the gaps and issues identified during the workshop would also be put forward.	AQD	AQD

In addition to the above projects and programs, there were also seven (7) **pipeline projects** of which the proposals are being prepared in consultation with respective donor agencies and the Member Countries.

Project Title	Department	Potential Donors
1. Sustainable Management of Fisheries, Marine Living Resources and their Habitats in The Bay of Bengal Region for the Benefit of Coastal States and Communities: Support to SEAFDEC Member Countries *	TD	FAO/GEF
2. Promoting Sustainable Use of the Gulf of Thailand Fishery Resources through the Blue Economy and the Ecosystem Approach to Fisheries (GoTFish)	TD	FAO/GEF
3. Piloting the electronic ASEAN Catch Documentation Scheme (eACDS) in Viet Nam	TD	World Bank
4. Blue Horizon: Ocean Relief through Seaweed Aquaculture in Southeast Asia	AQD	WWF-US/ GEF
5. Improving Healthy Ocean Ecosystems through Trawling Best Practices and Fishing Technology Innovations	TD	UNEP/GEF
6. Proposal on Implementation and Assessment of Fishing Capacity and Zoning System for Southeast Asia	MFRDMD	JAIF
7. Regional Technical Consultation on Aquatic Animal Health Emergencies in Southeast Asia	AQD	JAIF

* To be implemented under the FCG/ASSP mechanism once funding could be secured.

COOPERATION WITH DONORS AND OTHER ORGANIZATIONS IN 2020

Cooperation with International/Regional Organizations, Non-member Governments and Donors

- **Association of Southeast Asian Nations (ASEAN)**

The cooperation between the Association of Southeast Asian Nations (ASEAN) and SEAFDEC has been sustained since 1998 with the establishment of the Fisheries Consultative Group (FCG) Mechanism. The cooperation was formalized in 2007 with the signing of the Letter of Understanding on the ASEAN–SEAFDEC Strategic Partnership (ASSP), where SEAFDEC serves as technical arm to implement fisheries programs/projects for the benefit of the ASEAN Member States (AMSs). In 2020, sixteen (16) projects were implemented by SEAFDEC under the FCG/ASSP Mechanism. The progress and achievements in the implementation of these projects were reported to the Twenty-third Meeting of the FCG/ASSP organized on 17–18 November 2020 through Teleconference Session.

SEAFDEC also continued to support the AMSs in the implementation of activities in line with the "Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2020 (RES&POA-2020)" adopted in 2011, and the "Joint Declaration on Regional Cooperation for Combating IUU Fishing and Enhancing the Competitiveness of ASEAN Fish and Fishery Products" adopted in 2016. In 2020, SEAFDEC in collaboration with the ASEAN–SEAFDEC Member Countries reviewed and revised the RES&POA-2020, and came up with the draft "Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2030," which was approved by the SEAFDEC Council during its Fifty-second Meeting in May 2020, and endorsed for consideration by the ASEAN mechanism. Consequently, the Plan of Action was adopted by the "Special Senior Officials' Meeting of the Forty-first Meeting of the ASEAN Ministers on Agriculture and Forestry" on 5 August 2020, while the Resolution was adopted by the "Forty-second Meeting of the ASEAN Ministers on Agriculture and Forestry" on 21 October 2020.

In 2020, SEAFDEC was also represented in events organized by the ASEAN, namely:

- Technical Workshop on the Development of an ASEAN General Fisheries Policy (AGFP) Feasibility Study (27–28 May 2020, Virtual Meeting)
- Tenth Meeting of ASEAN Shrimp Alliance (ASA) (22 June 2020, Virtual Meeting)
- Twelfth Meeting of the ASEAN Fisheries Consultative Group (AFCF) (23 June 2020, Virtual Meeting)
- Twenty-eighth Meeting of the ASEAN Sectoral Working Group on Fisheries (ASWGFi) (25 June 2020, Virtual Meeting)
- ASEAN Fisheries Education Network (ASEAN-FEN) Webinar (10-11 October 2020, Virtual Meeting)

- **Charles Sturt University (CSU), Australia**

In April 2020, SEAFDEC/IFRDMD entered into an agreement with Charles Sturt University (CSU) of Australia through a Letter of Agreement (LOA) for sub-contracting of services for the implementation of research project "Modernizing irrigated agriculture to protect and

restore aquatic biodiversity and ecosystem services in South-East Asia" with funding by the Australian Water Partnership (AWP). The project has the objective of improving agricultural water management and irrigation practices in the Southeast Asian region to protect and restore fishery production, aquatic biodiversity and ecosystem services. Under this LOA, IFRDMD would be sub-contracted to carry out part of the project tasks. The duration of this Project is tentatively until October 2021.

- **Food and Agriculture Organization of the United Nations (FAO)**

In February 2020, SEAFDEC signed a Letter of Agreement (LOA) with the Food and Agriculture Organization of the United Nations (FAO) for the implementation of the project "Gender Dimension in the Value Chain of Small-scale Fisheries and Aquaculture in Southeast Asia." Under this LOA, FAO will provide funds to SEAFDEC/TD to implement the Project in participating countries, namely: Lao PDR, Myanmar, Philippines, and Thailand. The Project is aimed at enhancing the capacity of the participating countries' staff involved in fisheries management, and development programs and projects to enable them to integrate gender aspects in their respective program/project cycles. The duration of this LOA is from 1 January 2020 to 30 June 2021.

In 2020, SEAFDEC was involved in regional and international events organized by FAO with a view of ensuring that the activities and initiatives promoted by SEAFDEC are harmonized with relevant international instruments and initiatives. These include:

- Twenty-eighth Session of the Asia and Pacific Commission on Agricultural Statistics (APCAS) (organized by FAO/RAP on 10–14 February 2020 in Bali, Indonesia)
- Meeting on Capacity Development in Micro-finance, Credit and Insurance in Small-scale Fisheries (organized by FAO/APRACA Project on 29 April 2020 through Teleconference)
- Launching of the State of Fisheries and Aquaculture (SOFIA) 2020 (organized by FAO/Headquarters on 8 June 2020 through Webinar)
- Thirty-fifth Session of the FAO Regional Conference for Asia and the Pacific (organized by FAO/RAP on 1–4 September 2020 through Virtual Meeting)
- Webinar on Regional Aquaculture Reviews and State of World Aquaculture 2020 (organized by FAO on 26–29 October 2020)

In 2020, FAO also extended the expertise of resource persons in several events organized by SEAFDEC, including, among others the expertise of:

- *Mr. Marcio Castro de Souza* during the Webinar on Impact of COVID-19 on Fisheries and Aquaculture in Southeast Asia (organized by the SEAFDEC Secretariat on 2–3 July 2020); and the Webinar on Fisheries Subsidies: Southeast Asian Region Perspectives (organized by the SEAFDEC Secretariat on 23–24 September 2020)
- *Dr. Matthew Camilleri* during the Teleseminar on Way Forward for Combating IUU Fishing in Southeast Asia (organized by SEAFDEC/TD on 24–26 August 2020)
- *Dr. Jon Lansley* during the Online Meeting on Reducing Negative Impact to Ecosystem, Optimizing Energy and Fuel Consumption, and Enhancing Safety in Fishing Practices in Southeast Asia (organized by TD on 21 September 2020)
- *Dr. Simon Funge Smith* during the Regional Technical Consultation on Regional Plan of Action for the Management of Fishing Capacity (organized by SEAFDEC/MFRDMD on 8 December 2020 through Virtual Meeting)

- **Intergovernmental Organization for Marketing Information and Technical Advisory Services for Fishery Products in the Asia and Pacific Region (INFOFISH)**

On 11 September 2020, SEAFDEC signed a "Memorandum of Understanding" with the Intergovernmental Organization for Marketing Information and Technical Advisory Services for Fishery Products in the Asia and Pacific Region (INFOFISH) to cooperate in the scopes of: 1) Exchange of information including publications, subscriptions and library materials; 2) Joint research and capacity building activities of mutual interest as agreed by the Parties; 3) Participation of their respective officers and those of the Member Countries in technical trainings organized by either Party, as relevant and appropriate, and agreed by the Parties; and 4) Other activities or form of cooperation as may be mutually determined by the duly authorized representatives of the Parties. The MOU is effective starting from the signing date for a period of five years.

In 2020, SEAFDEC invited the representatives from INFOFISH to share their experiences as resource speakers in events, including among others:

- *Mr. Apimeleki Cokanasiga* during the Webinar on Impact of COVID-19 on Fisheries and Aquaculture in Southeast Asia (organized by the SEAFDEC Secretariat on 2-3 July 2020)

- **Japan–ASEAN Integration Fund (JAIF)**

In 2020, the Japan–ASEAN Integration Fund (JAIF) continued to provide financial support to SEAFDEC for the implementation of the Project "Strengthening the Effective Management Scheme with GIS (Geographic Information System) and RS (Remote Sensing) Technology for Inland Fisheries and Aquaculture at AMSs," which aims to use of GIS Mapping/RS Technology to understand the relationship between environmental data and the amount of catch for the effective management of inland fisheries and aquaculture. The Project which was scheduled to run until June 2020 was extended until 2021.

In 2020, JAIF also provided support to the new Project "Development of Stock Assessment Method and Strengthening of Resources Management Measures on Tropical Anguillid Eels in ASEAN Region" with the objective of collecting catch data and biological/ecological information for the estimation of eel resources stocks, and developing mathematical/statistical methods for estimating tropical anguillid eel resources stocks in order to formulate effective management measures for the sustainable use of tropical anguillid eels in Southeast Asia. This project would run from 2020 to 2021.

- **United Nations Environmental Program (UNEP)**

Since 2016, SEAFDEC has served as implementing agency for the Project "Establishment and Operation of a Regional System of Fisheries *Refugia* in the South China Sea and Gulf of Thailand" with funding support from the Global Environmental Facilities (GEF) through the United Nations Environmental Program (UNEP). The Project focuses on establishing a regional system of fisheries *refugia* by expanding the network of fisheries *refugia* in the South China Sea and Gulf of Thailand for improved management of fisheries and critical marine habitats, with Cambodia, Indonesia, Malaysia, Philippines, Thailand, and Viet Nam as participating countries. The duration of the project was from March 2016 to December 2020. Nevertheless, several activities scheduled in 2020 had to be postponed due to the

COVID-19 situation, and the "Second Ad-Hoc Meeting of the Project Steering Committee of the Fisheries *Refugia* Project" organized on 6 October 2020 agreed that the project would be continued for two more years. On 30 December 2020, SEAFDEC and UNEP therefore signed Amendment No. 1 of the Project Cooperation Agreement (PCA) to extend the duration of the project until 30 June 2023, and supported a no-cost extension with technical closure by 31 December 2022, and a financial closure by 30 June 2023.

Another project supported by GEF through UNEP was the "Strategic Action Programme for the South China Sea," the PCA for which was signed in January 2018. This Project is executed by the United Nations Office for Project Services (UNOPS) and SEAFDEC in six participating countries, namely: Cambodia, China, Indonesia, Philippines, Thailand, and Viet Nam. While UNOPS is responsible for national contract, staff and consultants; SEAFDEC is responsible for the project office, regional contract, meetings, training and conferences. Although the duration of the project is from 2018 until June 2023, this Project had encountered several delays so that the Project implementation started only in 2020 with the Project Inception Phase.

- **United States Agency for International Development (USAID)**

In 2020, the United States Agency for International Development Regional Development Mission for Asia (USAID/RDMA) launched the two-year "Sustainable Fish Asia (SUFIA)," which is implemented by the Research Triangle Institute (RTI) International in partnership with SEAFDEC and the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF). From the last quarter of 2020, the Project embarked on the activities under two Tasks, namely: Task 1 – organizational capacity assessment (OCA) and customized capacity development services for SEAFDEC and CTI-CFF; and Task 2 – private sector landscape assessment (PSLA) to identify opportunities for collaboration with private sector within the fisheries industry in the region.

- **United States Department of Interior (US-DOI)**

SEAFDEC signed in July 2018 the "Annex 2 to the Memorandum of Understanding (MOU) between the United States Department of Interior (US-DOI) and SEAFDEC Concerning Implementing the Lower Mekong Fish Passage Initiative in Cambodia, Thailand, and Vietnam." The specific objectives of this Annex are to: 1) Coordinate field fish passage barrier inventories in Cambodia, Thailand, and Viet Nam; 2) Design and construct one demonstration fish pass in Cambodia, one demonstration fish pass in Thailand, and one demonstration fish pass in Viet Nam; and 3) Sustain the Project administration and coordination. Under this Annex 2, SEAFDEC would provide support to the design and construction of one fish passage each in Cambodia, Thailand and Viet Nam; and the original Annex 2 had expired on 30 September 2019. Considering that there were still some activities that could not be finished by the expiry date, amendment to Annex 2 of the MOU was signed in February 2020 to extend the project period until 30 September 2021. Furthermore, in November 2020, another Amendment was made to the Annex to also include "Design and Construct Three (3) Additional Demonstration Fish Passes in Cambodia" within its existing timeframe.

Cooperation with National Agencies of SEAFDEC Member Countries

- **Japan Fisheries Research and Education Agency (FRA)**

Under the "Arrangement for Scientific and Educational Cooperation between Japan Fisheries Research and Education Agency (FRA) and SEAFDEC" which was signed in 2019, the FRA in 2020 continued to provide technical support to SEAFDEC.

Specifically, under such cooperative arrangement, a number of experts were dispatched to the SEAFDEC Departments, namely:

- *Dr. Koh-ichiro Mori* as Deputy Chief of AQD (until 30 June 2020)
- *Dr. Sayaka Ito* as Deputy Chief of AQD (since 1 October 2020)
- *Dr. Masaya Katoh* as Deputy Chief of MFRDMD
- *Dr. Takuro Shibuno* as Deputy Chief of IFRDMD (until 31 March 2020)
- *Dr. Toshiya Suzuki* as Deputy Chief of IFRDMD (since 1 April 2020)

In 2020, the FRA also provided resource persons in SEAFDEC technical activities, namely:

- *Dr. Jun Miyoshi* from National Research Institute of Fisheries Engineering (NRIFE) during the Online Meeting on Reducing Negative Impact to Ecosystem, Optimizing Energy and Fuel Consumption, and Enhancing Safety in Fishing Practices in Southeast Asia (organized by TD on 21 September 2020)
- *Dr. Tsutom Miyata* from National Research Institute of Fisheries Science (NRIFS) during the Seminar on Effective Approach and Methods to Promote Fisheries Resources Management in Small-scale Fisheries (organized by TD on 29 June 2020 through Online seminar)
- *Dr. Tom Nishida* from National Research Institute of Far Seas Fisheries during the Practical Workshop on Stock and Risk Assessments of Longtail Tuna (LOT) and Kawakawa (KAW) in the Southeast Asian Waters (organized by SEAFDEC Secretariat on 10–15 February 2020)
- *Mr. Kotaro Yokawa* from National Research Institute of Far Seas Fisheries during the Practical Workshop on Stock and Risk Assessments of Longtail Tuna (LOT) and Kawakawa (KAW) in the Southeast Asian Waters (organized by SEAFDEC Secretariat on 10–15 February 2020)

- **Gifu Prefecture, Japan**

SEAFDEC and the Gifu Prefecture of Japan established a 5-year Memorandum of Understanding (MOU) in 2016 with the aim of promoting educational and technical cooperation for the sustainable development of inland fisheries in the Southeast Asian region. Specifically, the MOU facilitates the dispatch of trainees from the Southeast Asian region to the Gifu Prefecture Inland Fisheries Training Center in Japan. While the Gifu Prefecture regularly supported the officers from the AMSs and SEAFDEC to participate in the training programs throughout the past years, the program in 2020 was suspended due to the COVID-19 situation. Nevertheless, SEAFDEC was invited by Gifu to deliver a keynote speech through tele-video during the "GISH Certification Commemorative Symposium" on 23 December 2020.

- **Graduate School of Agricultural and Life Sciences, and Faculty of Agriculture, the University of Tokyo (GSALS-UT), Japan**

The Arrangement of Cooperation between SEAFDEC and the Graduate School of Agricultural and Life Sciences, and Faculty of Agriculture, the University of Tokyo (GSALS-UT) was first established in 2004, and was extended in 2010 and 2015. Considering that the latest extension had expired on 14 July 2020, SEAFDEC therefore signed the "Extension of Arrangement for Academic and Educational Cooperation between SEAFDEC and GSALS-UT" on 30 March 2020. This Extension of Arrangement is an in integral part of the original Arrangement which aims to: 1) Encourage direct communication and cooperation between their respective research staff; and 2) Promote cooperation in areas of common concerns that are mutually agreed upon, *e.g.* exchange of information, joint research and training activities, visits by and exchange of researchers and students, visits by and exchange of staff, and participation by researchers and students in conferences and meetings on matters of mutual interest. The Extension of Arrangement is effective from 15 July 2020 for the duration of five years.

- **Hokkaido University, Japan**

The Arrangement for Scientific, Education, and Technical Cooperation between SEAFDEC and the Faculty of Fisheries Sciences, Hokkaido University of Japan (FFS-HU) was signed in 2006 for cooperation toward the sustainable development of fisheries, and was extended in 2011 and 2016. Under this cooperative framework, Hokkaido University continued to extend support to SEAFDEC and the Member Countries in 2020, with particular focus on onboard fisheries research survey method and fish stock assessment.

Specifically, Hokkaido University provided resource persons in SEAFDEC technical activities, namely:

- *Prof. Dr. Takashi Matsuishi Fritz* during the On-line Regional Training Course on Sampling Gear Design for Onboard Fisheries Resource Survey (organized by TD from 31 August to 4 September 2020) and the First Core Experts Meeting on Fisheries Management Strategies for Pelagic Fish Resources in the Southeast Asian Region (organized by MFRDMD on 24 November 2020 through Virtual Meeting).

- **Tokyo University of Marine Sciences and Technology (TUMSAT), Japan**

The Arrangement of Cooperation between the Tokyo University of Marine Science and Technology (TUMSAT) and SEAFDEC was first established in 2004, and extended in 2010 and 2015. Since the last extension had expired on 31 March 2020, SEAFDEC therefore signed the "Extension of Arrangement for Academic and Educational Cooperation between SEAFDEC and TUMSAT" on 23 March 2020 with the aim of sustaining the development of fisheries in the Southeast Asian region. This Extension of Arrangement is an integral part of the original Arrangement where SEAFDEC and TUMSAT endeavor to encourage direct contact and cooperation between their staff members, departments/research sections in the following forms of cooperation: 1) Collaboration of faculty and staff members for research, symposia and other academic pursuits; 2) Exchange of staff members and students for education, training and research; and 3) Exchange of data, documentation and research materials in the field of mutual interests. The Extension of Arrangement is effective starting from 1 April 2020 for the duration of five years.

In 2020, the TUMSAT provided a resource person during one of SEAFDEC technical activities:

- *Dr. Toshihide Kitakado* (Project Planning Meeting for the JAIF Project on Development of Stock Assessment Methods and Strengthening of Resources Management Measures for Tropical Anguillid Eel in Southeast Asia, organized by SEAFDEC Secretariat on 3 February 2020 in Bangkok, Thailand)

- **Marine Aquaculture Centre (MAC), Singapore**

The Post-harvest Technology Center (PHTC) of the Agri-Food & Veterinary Authority (AVA), Singapore served as Collaborating Centre of SEAFDEC to undertake the activities of MFRD under the SEAFDEC Regional Programmes from 2007 to 2019. In April 2019, a new statutory board, the Singapore Food Agency (SFA) was formed from the merger of AVA and part of 2 other statutory boards. The Marine Aquaculture Centre (MAC) of SFA replaced PHTC as the SEAFDEC Collaborating Centre to implement MFRD programmes in enhancing the development of fisheries post-harvest technology in the Southeast Asian region. In 2020, the implementation of the regional project "Enhancing Food Safety and Competitiveness of Seafood Products" supported by the Japanese Trust Fund to SEAFDEC, was continued by MAC.

PROGRESS IN THE IMPLEMENTATION OF INFORMATION STRATEGIES FOR ENHANCING SEAFDEC VISIBILIT AND COMMUNICATION IN 2020

Since its establishment, SEAFDEC has been implementing fisheries-related programs/projects that cover wide aspects of research, training and information. Starting in 2007, the SEAFDEC Secretariat and Departments made full use of the Information Strategies as guiding principles in formulating and implementing information-related activities that aim to enhance the Center's image and visibility. The Information Strategies have been developed to enhance the effectiveness of the implementation, monitoring, and reporting of the progress of SEAFDEC information-related activities.

In 2020, the progress and achievements made by SEAFDEC in the implementation of the Information Strategies were monitored and discussed during the Twenty-first Meeting of the Information Staff Program (ISP) on 30 November–1 December 2020 organized through online platform, corresponding to the five Information Strategies, as follows:

Strategy 1: Production of relevant, timely, and useful information material to meet the requirements of the target audience

- Technical/scientific materials: 38 title/issues produced: 10,032 copies published, with 5,166 hard-copies and 7,189 e-copy distributed
- Technical videos: 48 titles produced with 2,825 online views
- Technical/scientific articles: 67 titles produced: 23 titles published in SEAFDEC publications and 44 titles published in non-SEAFDEC publications
- Inquiries for information through the SEAFDEC libraries recorded and replied: 4,651 queries recorded (including 65 from e-mail, 2,235 from social media, 436 from website, 1,895 from repository, and 20 from library), 420 materials sold, and 20,060 citations

Strategy 2: Raising SEAFDEC image at national, regional, and international levels

- Promotional materials: 34 titles/issues produced: 20,040 copies published, with 13,380 hard-copies and 13,308 e-copies distributed
- Promotional souvenirs: 722 items produced, and 722 items distributed
- Promotion videos: 22 titles produced, with 287 online views
- SEAFDEC websites established: SEAFDEC Departmental websites had a total of 88,218 unique visitors, and 4,431 links from other websites
- Project websites: 2,200 unique visitors, and 133 links from other websites
- Social media administered by SEAFDEC: 34,752 followers, 2,380,484 likes, and 2,413,228 reaches
- Participation in exhibitions and related events: joined 1 exhibitions with 3,000 visitors recorded at SEAFDEC exhibition booths and displays
- Official press statements released: thirty-four (34) press statements released, and recorded 188 appearances of SEAFDEC in public media and websites

Strategy 3: Enhancing communication and information sharing both within SEAFDEC and with Member and non-Member Countries, other international/ regional organizations, and public

- Management of libraries of SEAFDEC Secretariat and Departments: SEAFDEC Secretariat and Departments libraries continued to provide library services
- Additional acquisitions of SEAFDEC libraries: total of 326 issues of newsletters/serial publications, and 166 titles of technical publications were acquired
- Cooperation and exchange of materials: sustained cooperation with 311 network libraries within and outside the region
- Dissemination of technical and promotional materials: 65 titles (with 5,355 copies) of technical materials, and 23 titles (with 13,048 copies) of promotional materials disseminated to target groups
- Accessibility of information materials: 5,314 downloadable materials, 515,235 downloads during reporting year, and 5 databases made accessible in SEAFDEC websites
- Institutional Repository: 3,030,849 unique visitors; 1,222 titles of materials uploaded during reporting year, 7,410 accumulated titles, and 523,877 downloads during reporting year
- Usage of e-mail systems (including e-groups) to facilitate communications both among SEAFDEC staffs and with other concerned personalities had been enhanced
- Direct visitors to SEAFDEC Secretariat and Departments: recorded a total number of 3,064 visitors (number of visitors in 2020 decreased due to the COVID-19 situation)
- Participation of SEAFDEC officials to events organized by other organizations: 168 SEAFDEC officials participated in 92 events: 90 officials at regional/international levels (14 in physical events and 76 in virtual events), and 78 officials at national/local levels (47 in physical events and 31 in virtual events)
- Number of presentations made by SEAFDEC Staff at non-SEAFDEC events: 14 oral presentations in events at regional/international levels; and 22 oral presentations in events at national/local levels
- SEAFDEC events organized:
  - International/regional meetings, seminars, workshops: 27 meetings with 1,809 participants (4 physical events with 104 participants, and 23 virtual events with 1,705 participants)
  - National/local meeting, seminars, workshops, consultations: 16 meetings with 497 participants (15 physical events with 357 participants, and 1 virtual event with 140 participants)
  - International/regional training courses: 3 courses with 56 trainees (all on-line training courses)
  - National, on-site training courses: 18 courses with 491 trainees (10 physical training courses with 232 trainees, and 8 on-line training courses with 259 trainees)
  - Study tours: 4 programs with 59 trainees
  - Internships: 1 group with 9 interns
  - On-the-job training: 4 colleges participated with a total of 52 students
  - Internal meetings: 18 meetings with 457 participants (7 physical meeting with 139 participants, and 11 virtual meeting with 318 participants)

- Participation of officials from Member Countries in events organized by SEAFDEC:
  - International/regional meetings, seminars, workshops (1,049 participants)
  - National/local meetings, seminars, workshops, consultations (460 participants)
  - International/regional training courses (54 trainees)
  - National on-site training courses (422 trainees)
  - Study tours (10 trainees)
  - Internships (9 persons)
  - On-the-Job training (44 students)
- Network and cooperation mechanisms established (now with 42 fisheries-related organizations) for the implementation of collaborative activities at national, regional and international levels
- Support from other organizations and donor agencies for relevant activities solicited: total support received in 2020: US$ 5,800,082 representing non-regular sources of funds for the activities of SEAFDEC (US$ 2,727,740 from agencies/institutions in the region and US$ 3,072,333 from agencies/institutions outside the region)

Table 1. Participation of Member Countries in SEAFDEC Events in 2020

Category	Participants from Member Countries (persons)										
	Brunei Darussalam	Cambodia	Indonesia	Japan	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Viet Nam
SEAFDEC regional/international meetings, seminars, workshops	35	55	133	60	13	118	73	278	29	191	64
SEAFDEC national/local meetings, seminars, workshops, consultations	2	25	189	2	0	143	1	0	0	97	1
International/regional training courses	13	4	7	0	2	4	4	10	2	4	4
National, on-site training courses (course/trainees)	10	0	0	0	16	13	0	234	0	136	13
Study tours (no. of program/ trainees)	0	0	0	0	0	9	0	0	0	0	0
Internships (group/persons)	0	0	0	0	0	0	0	9	0	0	0
On-the-job training (college/ students)	0	0	0	0	0	0	0	40	0	4	0
SEAFDEC internal events	0	0	0	6	0	0	0	0	0	0	0
TOTAL	**60**	**84**	**329**	**68**	**31**	**287**	**78**	**571**	**31**	**432**	**82**

Strategy 4: Strengthening SEAFDEC capability in information-related activities

- Capabilities of SEAFDEC staff in information-related offices enhanced (through HRD taking into account the scope and requirements of concerned staff, and during annual ISP Meetings)

- Financial sustainability of SEAFDEC institutional publications and information activities boosted (through intensified sale of technical publications and souvenir items on cost-recovery basis)

Strategy 5: Regular monitoring and evaluation of information activities

- Feedback on materials produced by SEAFDEC obtained (developed for the training, research, and information transfer through communication channels, *e.g.* dedicated e-mail, etc.)
- Twenty-first Meeting of the SEAFDEC Information Staff Program (ISP) organized to monitor the implementation of information-related activities, in accordance with the Information Strategies to Enhance SEAFDEC Visibility and Communication (convened on 30 November–1 December 2020 through Online Meeting)

PROGRESS IN THE IMPLEMENTATION OF SEAFDEC GENDER STRATEGY IN 2020

The SEAFDEC Gender Strategy was approved by the Fifty-first Meeting of the SEAFDEC Council in 2019 for implementation by the SEAFDEC Secretariat and Departments with the goal of making *"SEAFDEC gender-responsive and gender-sensitive in pursuing sustainable development and management of fisheries and aquaculture in Southeast Asia."* The Progress in the implementation of the Gender Strategy by SEAFDEC during the year 2020 is summarized as follows:

Strategy 1: Mainstreaming gender at all levels of the organization

- Policies and regulations for the staff: generally applied equally to male and female, with some specific gender-related policy, *e.g.* maternity/paternity leave, special leave benefits for women
- Gender-related facilities: provided as and when necessary, *e.g.* breastfeeding areas, child care facilities, prayer room for Muslim men/women
- Number of staff in HR system: total of 541 staff (210 female and 331 males) at the SEAFDEC Secretariat and five Departments

Strategy 2: Integrating gender in SEAFDEC programs and projects

- Gender sensitive[1] programs/projects: 4 regional projects (out of 16) are gender sensitive
- Stakeholders and participants involved in programs/projects of SEAFDEC: 3,560 stakeholders/ participants (1,119 females and 1,522 males)
- Gender-related events organized by SEAFDEC: 2 events, with 32 participants (15 females and 17 males)

Strategy 3: Incorporating gender perspectives in all events organized by SEAFDEC

- Sex disaggregated number of participants in events organized by SEAFDEC:
  - Regional/international meetings, seminars, workshops: 27 events, with 1,809 participants (806 female and 963 male)
  - SEAFDEC national/local meetings, seminars, workshops, consultations, etc.: 16 events, with 497 participants (80 female and 229 male)
  - International/ regional training courses: 3 events, with 56 participants (17 female and 39 male)
  - National, on-site training courses: 18 events, with 491 participants (208 female and 283 male)
  - Study tours: 4 events, with 59 participants (25 female and 34 male)
  - Internships (group/persons): 1 event, with 9 participants (4 female and 5 male)
  - On-the-job trainings (students): 4 events, with 52 participants (31 female and 21 male)
  - SEAFDEC Internal Events: 18 events, with 457 participants (172 female and 179 male)

[1]Gender sensitive refers to the programs and projects where gender norms, roles and inequalities have been considered and awareness of these issues has been raised

Strategy 4: Boosting the visibility of SEAFDEC as a gender-responsive and gender-sensitive organization

- Articles/papers/reports published and distributed: 4 titles, with 3,700 hard-copies produced, 1,590 hard-copies distributed, and 511 e-copy downloaded.
- Presentation on gender-related subject at events organized by other organizations: one (1) oral presentation

Strategy 5: Strengthening further the cooperation and collaboration with Member Countries and other organizations on gender aspects

- Collaboration with two (2) organizations for their representatives to serve as resource persons at events organized by SEAFDEC, and provide inputs to questionnaire survey conducted by SEAFDEC

SEAFDEC REVENUES AND EXPENDITURES IN 2020

Southeast Asian Fisheries Development Center

Un-Audited Abridged Consolidated Financial Statements as at December 31, 2020 and 2019 (in US$)

	2020 (Un-audited)		2019 (Audited)	
REVENUES				
Contributions from :-				
Member governments	11,173,205		10,879,078	
Other sources	1,008,881		2,352,403	
Other income	707,761		491,178	
TOTAL REVENUES	**12,889,847**		**13,722,659**	
EXPENDITURES				
Operating and Capital Expenditures :-				
Research	3,664,276		3,774,923	
Training	1,128,858		1,678,197	
Information	607,546		690,511	
Collaborative	131,464		201,043	
Others	297,478		740,888	
Administrative	4,376,603		4,772,618	
TOTAL EXPENDITURES	**10,206,225**		**11,858,180**	
SURPLUS (DEFICIT), For the year	2,683,622		1,864,479	
FUND BALANCE, Beginning of year	15,191,064	1/	13,032,591	
FUND ADJUSTMENT	(7,890)		(1,162)	
FUND BALANCE, End of year	**17,866,796**		**14,895,908**	1/
REPRESENTED BY :				
ASSETS				
Current assets				
Cash and cash equivalents	17,811,309		15,938,412	
Receivables and other receivables	545,025		465,279	
Advance and deposits	58,702		22,023	
Materials and supplies inventory	43,052		26,258	
Fuel oil for vessels	180,437		215,910	
Prepayments	6,465		7,875	
Other current assets	4,055		1,923	
Total Current assets	**18,649,045**		**16,677,680**	
Noncurrent assets				
Reserved budget for vessel periodic maintenance	301,466		231,642	
Termination indemnity fund	2,474,403		2,521,454	
Long-term investments	497,038		273,906	
Other noncurrent assets	266,302		215,110	
Total Noncurrent assets	**3,539,209**		**3,242,112**	
TOTAL ASSETS	**22,188,254**		**19,919,792**	
Less: Liabilities				
Accrued payable	732,705		732,705	
Contribution received in advance	862,250		862,250	
Fund held in trust	252,100		252,100	
Total Current Liabilities	**1,847,055**		**1,847,055**	
Provision for termination indemnity	2,474,403		2,474,403	
TOTAL LIABILITIES	**4,321,458**		**4,321,458**	
NET ASSETS	**17,866,796**		**17,866,796**	

Remark:
1/ The Difference of US$ 295,156 (US$ 15,191,064 – US$ 14,895,908) resulted from the change of rate in US$ translation.

Un-Audited Contribution Received by SEAFDEC from Member Countries and Other Sources for the Year 2020 (in US$)

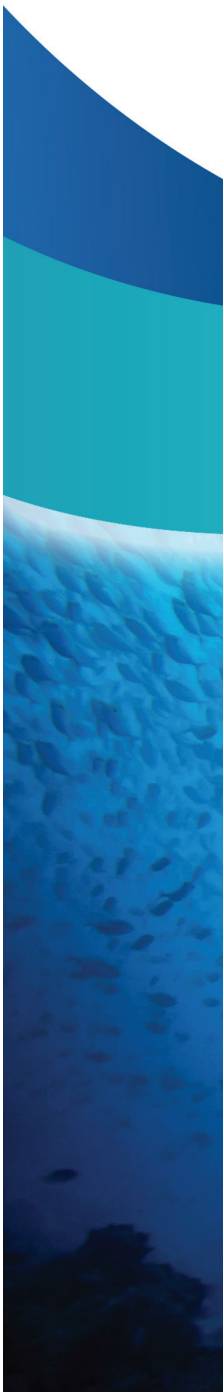
Sources	Secretariat	TD	MFRD	AQD	MFRDMD	IFRDMD	Total	
							In US$	%
Brunei Darussalam	7,000	-	-	-	-	-	7,000	0.06
Cambodia	12,000	-	-	-	-	-	12,000	0.09
Indonesia	52,000	-	-	-	-	561,491	613,491	4.76
Japan	280,000	-	-	-	-	-	280,000	2.17
Lao PDR	6,500	-	-	-	-	-	6,500	0.05
Malaysia	21,500	-	-	-	760,094	-	781,594	6.06
Myanmar	22,500	-	-	-	-	-	22,500	0.18
Philippines	25,000	-	-	6,038,773	-	-	6,063,773	47.04
Singapore	13,500	-	-	-	-	-	13,500	0.10
Thailand	33,000	3,313,847	-	-	-	-	3,346,847	25.97
Viet Nam	26,000	-	-	-	-	-	26,000	0.20
Sub-total	**499,000**	**3,313,847**	**-**	**6,038,773**	**760,094**	**561,491**	**11,173,205**	**86.68**
Other Sources/ Grant[2/]	-	748,699	-	260,182	-	-	1,008,881	7.83
Other income	12,930	83,704	-	611,127	-	-	707,761	5.49
Total	**511,930**	**4,146,250**	**-**	**6,910,082**	**760,094**	**561,491**	**12,889,847[3/]**	**100.00**

Remarks:
[2/] Including contribution from non-member governments, International organization/agencies and miscellaneous receipts.
[3/] Excluded contribution received for the year 2020 which supported form Fisheries Agency-Japan for Japanese Trust Fund for the amount US$ 1,550,357 (Excluded Japan-MRC = US$ 280,000) from Japan-ASEAN Integration Fund (JAIF) for EEL Project for the amount of US$ 553,086

Un-audited Other Contributions Received by SEAFDEC In 2020 (in US$)

	Amount in US$ [4/]
Japanese Trust Fund (excluded: Japan MRC = US$ 280,000)	1,550,357
Japan-ASEAN Integration Fund (JAIF) for EEL Project	553,086
Total	**2,103,443**

Remark:
[4/] Other sources of contribution which are not reported in the SEAFDEC Financial Statements



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