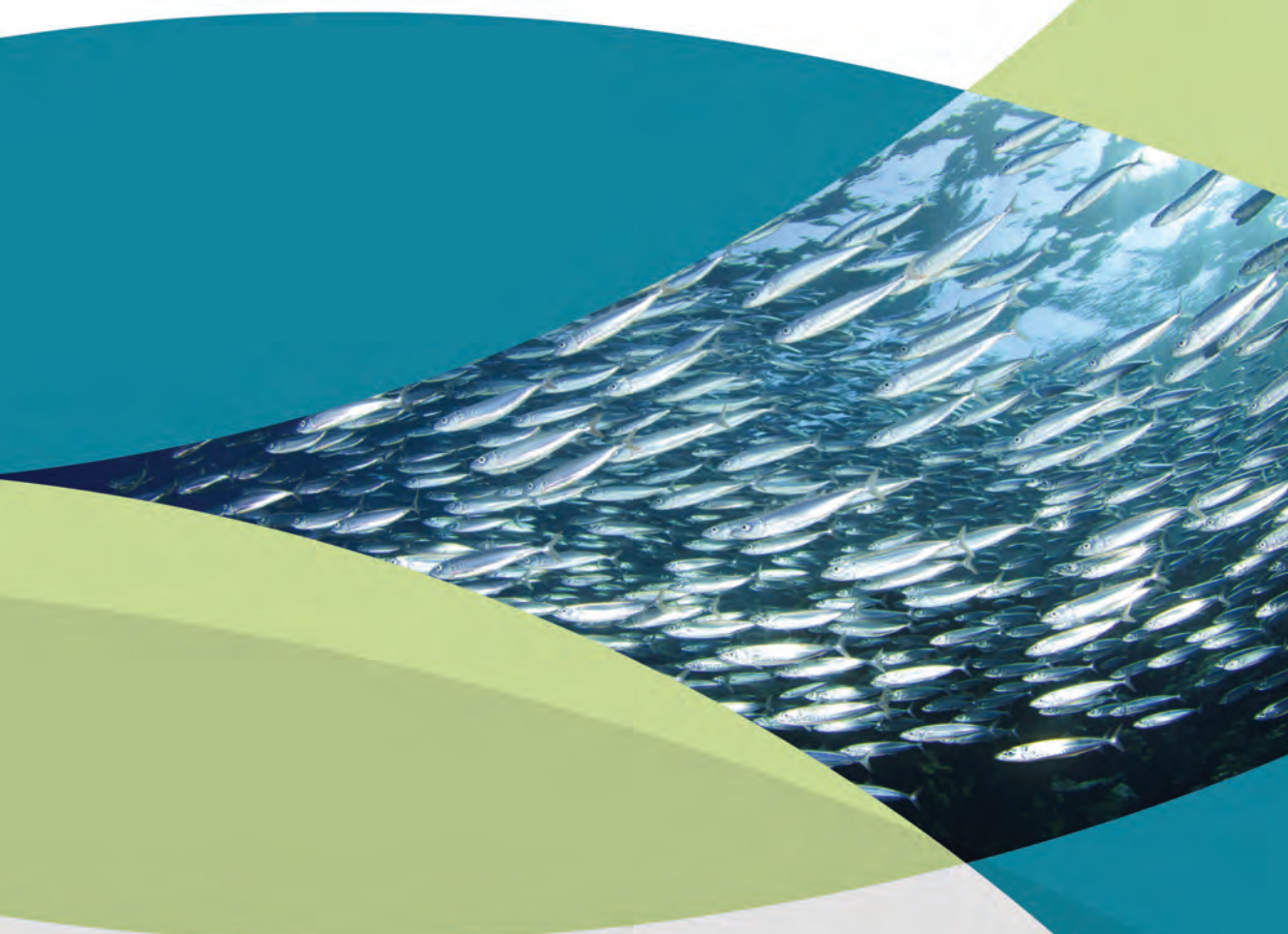


# SEAFDEC Annual Report 2021



Southeast Asian Fisheries Development Center

# SEAFDEC Annual Report

# 2021



Southeast Asian Fisheries Development Center

## Preparation and Distribution of this Document

This SEAFDEC Annual Report 2021 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 2021 is distributed to the SEAFDEC Member Countries and Departments, collaborating agencies, fisheries-related organizations, and to the public to promote the activities and achievements as well as the visibility of SEAFDEC.

## Bibliographic Citation

SEAFDEC. (2022). *SEAFDEC Annual Report 2021*. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 124 p



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## EXECUTIVE SUMMARY

The progress and achievements of SEAFDEC through the programs and activities undertaken in 2021 were summarized in this SEAFDEC Annual Report 2021. The programs implemented by SEAFDEC were in line with the priority needs and policy directives of the Member Countries that were conveyed through the SEAFDEC Council and the SEAFDEC Program Committee, and were 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 (5 programs). Moreover, these programs had 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 of the approved programs in 2021, 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 shared 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 coronavirus disease 2019 (COVID-19) situation which had been prolonged from 2020 until 2021, SEAFDEC continued to carry out the activities as planned, but mostly through virtual means with a view of ensuring that such programs could continue to address the common concerns of the Member Countries. Moreover, efforts have been sustained by the SEAFDEC Secretariat and Departments to implement the Strategies for Enhancing SEAFDEC Visibility and Communications and the SEAFDEC Gender Strategy, the progress of which were compiled and summarized in this Annual Report.

It is the hope of SEAFDEC that the Annual Report 2021 would serve as a reference for the SEAFDEC Member Countries, collaborating organizations, and the public in obtaining a better view of the roles, activities, and achievements of SEAFDEC in supporting the Member Countries in their respective efforts towards achieving sustainable development of fisheries in the Southeast Asian region.

## MESSAGE FROM THE CHAIRPERSON OF THE SEAFDEC COUNCIL



The year 2021 continued to be another challenging year for the countries in the Southeast Asian region due to the prolonged COVID-19 situation since 2019. Throughout the past two years, the restriction measures to contain the spread of the virus had affected the demand and supply chain of fish and fishery products all over the world including Southeast Asia. Consequently, the countries in the region had been working hard to come up with measures to mitigate such impacts, especially to sustain the socioeconomic condition and food security of people dependent on fishery resources.

It should also be recalled that in 2021, we had been working toward welcoming the “International Year of Artisanal Fisheries and Aquaculture” or IYAF2022. Several countries in the region are rich in natural aquatic resources not only in marine but also in inland fisheries that provide livelihood and food security to small-scale fishers and fish farmers. SEAFDEC has implemented several programs that directly address the needs to ensure the sustainability of small-scale fisheries, such as the promoting ecosystem approach to fisheries management or EAFM and co-management, fostering gender equality, and developing responsible fishing and aquaculture technologies applicable for small-scale operators, among others. I truly acknowledge the importance of these programs that contributed to strengthening the capacity of the Member Countries for the promotion of small-scale fisheries toward sustainability.

Moreover, on behalf of all the Member Countries, I would also like to express my appreciation to SEAFDEC for continuing other priority activities in line with the Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2030, especially on combating IUU fishing, understanding of the status of fishery resources, protecting and managing aquatic habitats, and supporting countries toward sustainable utilization of fishery resources and compliance with emerging requirements of international trade of fish and fishery products. Although physical events were not possible in 2021 due to the COVID-19 situation, several activities, such as consultations, training courses, workshops, among others were successfully conducted by SEAFDEC through an online platform.

On this occasion, I would like also to congratulate the SEAFDEC Secretariat and Departments for exerting efforts in implementing several programs of activities, and the progress of which had been summarized in this SEAFDEC Annual Report 2021. Moreover, I would like to express my appreciation to partner organizations for extending their support and cooperation to SEAFDEC throughout the year as well as for their commitment to future cooperation. On behalf of the SEAFDEC Council, I would like to convey my full support to SEAFDEC in its works toward the sustainable development of fisheries in the Southeast Asian region in the years to come.

A handwritten signature in blue ink, appearing to read 'Vilayphone Vorraphim', with a stylized flourish at the end.

*Mrs. Vilayphone Vorraphim*  
Director-General  
Department of Livestock and Fisheries,  
Ministry of Agriculture and Forestry, Lao People's  
Democratic Republic

## MESSAGE FROM THE SEAFDEC SECRETARY-GENERAL



In 2021, SEAFDEC continued to sustain its programs and projects with a view of supporting the sustainable development and management of fisheries in Southeast Asia. The “Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2030” adopted in 2020 continued to be the regional policy framework that guided the formulation and implementation of SEAFDEC programs and projects. This SEAFDEC Annual Report 2021, therefore, summarized the activities undertaken by the Center in collaboration with the Member Countries throughout the year.

While the contribution of the region’s fisheries sector to global fishery production is recognized to be significant, the need to ensure that the fishery resources are utilized in a sustainable manner is undeniable. SEAFDEC, in 2021, therefore continued to focus our activities on addressing priority issues of the Member Countries. Combating IUU fishing and enhancing the traceability of fish and fishery products remained to be among the highlighted subjects; while activities aimed at sustaining and reducing the impacts of fishing and aquaculture on the ecosystems were also continued, *e.g.* through promoting responsible fishing and aquaculture technologies/practices, optimizing the use of energy and labor in fishing activities, studying the impacts of fishing gears/activities including lost/discarded gears, safeguarding important aquatic habitats and ecosystems, and making full use of the harvested resources. Moreover, with more stringent requirements to ensure that fish is harvested in a sustainable manner, the need to obtain information on the status of fishery resources is becoming more necessary. Through a series of activities of SEAFDEC in 2021, we truly hope that our activities had been an important part of the region’s efforts in addressing such pressing issues faced by the fisheries sector.

I would like to take this opportunity to express the sincere appreciation on behalf of SEAFDEC to our collaborating partners who have worked with us in the implementation of our programs and projects throughout 2021. I would like also to express our gratitude to the Member Countries, particularly the Council of Directors for extending guidance on the operation and management of SEAFDEC. Moreover, I also wish to express our appreciation to the Government of Japan and other donor organizations for providing funds as well as for dispatching several experts and resource persons to share their knowledge and experiences that led to strengthening SEAFDEC as an organization and successful implementation of our programs and projects.

At the end of 2021, we seem to have a good signal that the COVID-19 pandemic may be resolved in the coming year. We, therefore, look forward to working with the Member Countries with the more intense implementation of programs and projects in 2022, and to render our best efforts to address the priority issues and ensure the sustainable development and management of fisheries for the benefit of people in the Southeast Asian region.

A handwritten signature in purple ink that reads "Malinee".

*Ms. Malinee Smithrithee*  
Secretary-General

## LIST OF ACRONYMS

|             |   |
|-------------|---|
| ACDS        | ASEAN Catch Documentation Scheme  |
| ACIAR       | Australian Centre for International Agricultural Research                         |
| 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  |
| ASPIC       | A Stock-Production Model Incorporating Covariates                                 |
| 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 |
| 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   |
| 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                        |
| PCA      | Project Cooperation Agreement   |
| PSM      | Port State Measures   |
| PSMA     | Port State Measures Agreement   |
| RDMA     | Regional Development Mission for Asia, USAID                                |
| RS       | Remote Sensing  |
| RFVR     | Regional Fishing Vessels Record   |
| RPOA     | Regional Plan of Action   |
| SFA      | Singapore Food Agency   |
| SEAFDEC  | Southeast Asian Fisheries Development Center                                |
| SEC      | SEAFDEC Secretariat   |
| SOM-AMAF | Senior Officials Meeting of the ASEAN Ministers on Agriculture and Forestry |
| SPECTRA  | Special Area for Conservation and Fish <i>Refugia</i>                       |
| SUFIA    | Sustainable Fish Asia   |
| SWG      | Scientific Working Group  |
| TOR      | Terms of Reference  |
| TD       | SEAFDEC Training Department   |
| UNEP     | United Nations Environment 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 Wildlife Fund, Inc.   |



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## ABOUT SEAFDEC

The Southeast Asian Fisheries Development Center (SEAFDEC) is an autonomous inter-governmental body established in 1967. SEAFDEC comprises 11 Member Countries, namely: 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.”*

### SEAFDEC Secretariat

The SEAFDEC Secretariat is mandated to coordinate and oversee the general policy and planning of the Center, and acts as the 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

### 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 advancement of 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 also cover 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

### Marine Fisheries Research Department (MFRD)

MFRD was established in Singapore in 1969 and is responsible for promoting, undertaking, and coordinating research on 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, 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) in 2019, the SFA continued to uphold the commitment of Singapore to implement the MFRD programmes.



SEAFDEC/MFRD

### **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, mangrove 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

### **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 on the compilation of information on small pelagic species and the establishment of indicators that could be used for the sustainable development and management of fisheries.



SEAFDEC/MFRDMD

### **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 the sustainable development and management of inland fisheries in the Southeast Asian region.



SEAFDEC/IFRDMD

## SEAFDEC COUNCIL OF DIRECTORS IN 2021

### Chairpersons of the SEAFDEC Council

Mr. Shingo Ota (*until 4 April 2021*)

Mr. Takashi Koya (*from 5 April to 27 April 2021*)

Mrs. Vilayphone Vorraphim (*since 27 April 2021*)

### 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** (*until 1 March 2021*)  
Delegate of the Royal Government of Cambodia, and  
Director-General, Fisheries Administration

**Mr. Ing Try** (*since 2 March 2021*)  
Deputy Director General, Fisheries Administration

Alternate Council Director: **Mr. Buoy Roitana**  
Deputy Director-General, Fisheries Administration

#### Indonesia

Council Director: **Mr. Antam Novambar**  
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** (*until 4 April 2021*)  
Councillor, Resource Management Department, Fisheries  
Agency, Ministry of Agriculture, Forestry and Fisheries

**Mr. Takashi Koya** (*since 5 April 2021*)  
Director-General, Fisheries Agency of Japan

Alternate Council Director: **Mr. Shige Watanabe** (*until 7 March 2021*)  
Director, First Country Assistance Planning Division,  
International Cooperation Bureau, Ministry of Foreign  
Affairs

**Mr. Masahiro Takehana** (*since 8 March 2021*)  
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. Chanthaboun Sirimanotham** (*until 3 February 2021*)  
Deputy Director-General, Department of Livestock and Fisheries  
**Dr. Kaviphone Phouthavong** (*since 4 February 2021*)  
Deputy Director-General, Department of Livestock and Fisheries

## Malaysia

- Council Director: **Mr. Ahmad Tarmidzi bin Ramly, AMK**  
Director General, Department of Fisheries Malaysia
- Alternate Council Director: **Mr. Raja Bidin bin Raja Hassan**  
Deputy Director General (Fisheries Development),  
Department of Fisheries Malaysia

## Myanmar

- Council Director: **Mr. Wai Lin Maung**  
Director-General, Department of Fisheries
- Alternate Council Director: **Mr. Myint Zin Htoo**  
Deputy Director-General, Department of Fisheries

## Philippines

- Council Director: **Ms. Cheryl Marie Natividad-Caballero**  
Undersecretary for Agri-industrialization and 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** (*until 28 January 2021*)  
Deputy Director-General, Department of Fisheries  
**Mr. Taworn Thanjai** (*Since 29 January 2021*)  
Deputy Director-General, Department of Fisheries

## **Viet Nam**

Council Director:

**Dr. Tran Dinh Luan**

Deputy Director General, 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 2021

### **Secretary-General**

*Ms. Malinee Smithrithee*

### **Deputy Secretary-General**

*Mr. Koichi Honda*

## **Training Department (TD)**

### **Chief**

*Ms. Malinee Smithrithee*

### **Deputy Chief**

*Mr. Koichi Honda*

## **Marine Fisheries Research Department (MFRD)**

### **Chief, MFRD Programmes**

*Mr. Ong Yihang*

## **Aquaculture Department (AQD)**

### **Chief**

*Mr. Dan D. Baliao*

### **Deputy Chief**

*Dr. Sayaka Ito*

## **Marine Fishery Resources Development and Management Department (MFRDMD)**

### **Chief**

*Dr. Ahmad Ali (until July 2021)*

*Dr. Masaya Katoh (Acting, from August to December 2021)*

### **Deputy Chief**

*Dr. Masaya Katoh*

## **Inland Fishery Resources Development and Management Department (IFRDMD)**

### **Chief**

*Dr. Arif Wibowo (until 27 December 2021)*

*Mr. Zulkarnaen Fahmi (since 28 December 2021)*

### **Deputy Chief**

*Dr. Toshiya Suzuki*

## OVERVIEW OF SEAFDEC PROGRAMS IN 2021

The activities of SEAFDEC in 2021 were formulated and implemented in line with the policy directives given by the SEAFDEC Member Countries during SEAFDEC annual meetings, *i.e.* Forty-third Meeting of the SEAFDEC Program Committee (10–12 November 2020, online meeting), Twenty-third Meeting of the Fisheries Consultative Group of the ASEAN–SEAFDEC Strategic Partnership (FCG/ASSP) (17–18 November 2020, online meeting), and Fifty-third Meeting of SEAFDEC Council (27–28 April 2021 and 11 May 2021, online meeting).



*Delegates attending the Fifty-third Meeting of the SEAFDEC Council*

Moreover, the development and implementation of the SEAFDEC programs and activities for 2021 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 2030” adopted by the ASEAN Senior Officials and Ministers during the Special Senior Officials’ Meeting of the 41<sup>st</sup> Meeting of the ASEAN Ministers on Agriculture and Forestry on 5 August 2020, 42<sup>nd</sup> Meeting of the ASEAN Ministers on Agriculture and Forestry on 21 October 2020, as well as the Senior Official and Minister responsible for fisheries of Japan *ad referendum*. Furthermore, the programs and activities of SEAFDEC, especially those under the ASEAN–SEAFDEC Strategic Partnership (ASSP), also support the ASEAN in its efforts in the implementation of the “Strategic Plan of Action on ASEAN Cooperation on Fisheries 2021–2025.” 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.

The progress of implementation of the programs and activities in 2021 was considered and endorsed by the Forty-fourth Meeting of the SEAFDEC Program Committee organized on 15–17 November 2021 and Twenty-fourth Meeting of the Fisheries Consultative Group of the ASEAN–SEAFDEC Strategic Partnership (FCG/ASSP) on 24–25 November 2021, both as online meeting; and would be submitted to the SEAFDEC Council at its Fifty-fourth Meeting in 2022.





*Participants of the Forty-fourth Meeting of the SEAFDEC Program Committee*



*Participants of the Twenty-fourth Meeting of the FCG/ASSP*

The programs and projects implemented by SEAFDEC in 2021 are shown below:

**1) Projects under the ASEAN–SEAFDEC FCG/ASSP Mechanism**

| Strategy/Project Title   | Lead Department | Funding Source |
|--|-----------------|----------------|
| <b>Strategy I: Securing the sustainability of fisheries to contribute to food security, poverty alleviation and livelihood of people in the region</b> |                 |                |
| 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            |

| Strategy/Project Title   | Lead Department | Funding Source |
|--|-----------------|----------------|
| 5. Sustainable Utilization of Anguillid Eels in the Southeast Asian Region   | IFRDMD          | JTF            |
| 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 <i>Refugia</i> in the South China Sea and Gulf of Thailand   | TD              | UNEP/GEF       |
| 11. 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           |
| <b>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</b> |                 |                |
| 13. Sustainable Aquaculture through Cost-effective Culture Systems, and Prompt and Effective Aquatic Animal Health Management  | AQD             | JTF            |
| <b>Strategy III: Ensuring the food safety and quality of fish and fishery products for the Southeast Asian region</b>  |                 |                |
| 14. Enhancing Food Safety and Competitiveness of Seafood Products  | MFRD            | JTF            |
| <b>Strategy IV: Enhancing trade and compliance of the region's fish and fishery products with market requirements</b>  |                 |                |
| -  |                 |                |
| <b>Strategy V: Addressing cross-cutting issues, such as labor, gender and climate change, where related to international fisheries</b>   |                 |                |
| 15. Assistance for Capacity Development in the Region to Address International Fisheries-related Issues  | SEC             | JTF            |
| <b>Strategy VI: Empowering SEAFDEC to strengthen its roles in the region and to improve its services to Member Countries</b>   |                 |                |
| 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. Improving 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       |
| 4. Survey to Estimate Levels of Abandoned, Lost or Otherwise Discarded Fishing Gear in Thailand Gillnet and Trap Fisheries | TD         | FAO            |
| 5. Fishing Technologies and Operations in Thailand and Options for Innovation and Improvements                             | TD         | FAO            |

## SEAFDEC PROGRAMS OF ACTIVITIES IN 2021

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 2021, 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 2030*” adopted in 2020, 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 2021 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.

The difficulties encountered by SEAFDEC in the implementation of programs of activities due to the COVID-19 pandemic had continued in 2021. Some national activities could be carried out by the SEAFDEC Departments in their respective host countries, however, the implementation of regional activities or activities in the other SEAFDEC Member Countries had been either adjusted or undertaken through online platforms, or postponed until the situation has improved.

The results and progress of the programs and activities of SEAFDEC implemented in 2021 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**

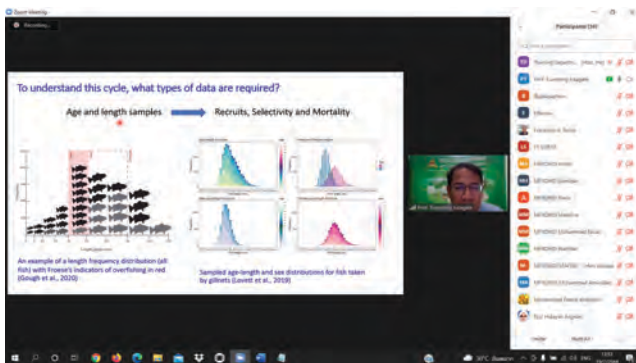
#### **1.1 Assessment and management of marine fish stocks**

##### ***Sustainable Utilization of Fisheries Resources and Resources Enhancement in Southeast Asia***

The role of fisheries in the socioeconomic development of countries all over the globe is widely recognized, while the production from fisheries is also known to provide the primary sources of protein for people and contribute to the livelihoods of various groups of stakeholders. Throughout the past decades, the demand for marine fish and 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, over several decades, fisheries in Southeast Asia have exceeded its point of sustainability. Some of the commercially important marine fishery resources in the region have declined due to various factors, making it necessary to mitigate the problems and improve the utilization of such resources towards sustainability. One of the

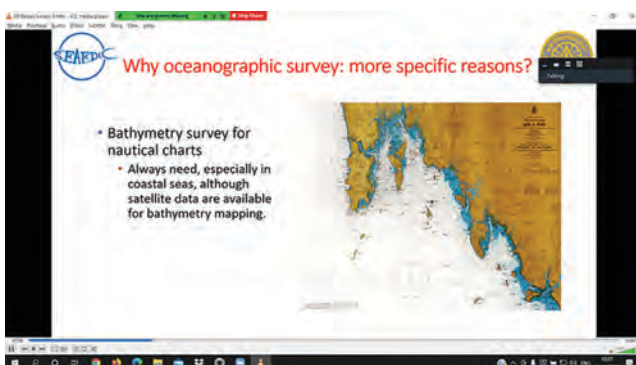
projects implemented by SEAFDEC to mitigate such problems is the project “**Sustainable Utilization of Marine Fisheries Resources and Resources Enhancement in Southeast Asia.**” Implemented by TD, the duration of the Project is from 2020 to 2024 with the aims of improving science-based knowledge and building the technical capacity of fisheries officers and researchers from the Member Countries to conduct relevant research.

In 2021, under the activity to enhance the technical capacity of human resources to conduct marine fishery resources and oceanographic research/survey in Southeast Asia, TD conducted three regional training courses. The first was the “Training Course on Fish Population Dynamics and Fisheries Management Using R-statistical Program” organized from 19 to 23 July 2021. This training course was organized through online platform with the aims of enhancing the capacity of human resources from the ASEAN Member States (AMSs) and strengthening the network of researchers on fish population dynamics and fisheries management in the Southeast Asian region on fish population dynamics and fisheries management using R-statistical program. The Training was participated by 50 fisheries officers and researchers from the AMSs.



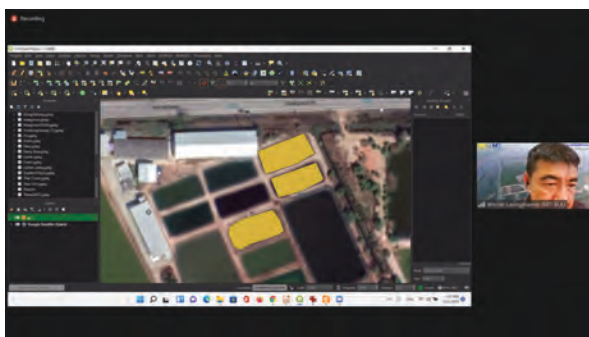
*Training Course on Fish Population Dynamics and Fisheries Management Using R-statistical Program*

The second course was the “Regional Training Course on the Relationship between Ocean Environment Variability and Fisheries Resource Abundance and Oceanographic Sampling” from 22 to 26 November 2021 via the online platform. The objectives of the training course were to improve the knowledge of the participants on the relationship between ocean environment variability and fishery resource abundance, and to enhance their capacity to carry out oceanographic surveys focusing on sampling methods. This course was attended by 29 participants including junior fishery officers and researchers from the AMSs.



*Regional Training Course on the Relationship between Ocean Environment Variability and Fisheries Resource Abundance and Oceanographic Sampling*

The third training course under this Project was the “Regional Online Training Course on Geographic Information System (GIS) and Remote Sensing (RS) for Aquaculture” from 30 November to 3 December 2021 via the online platform. The goal of the Training was to enhance the capacity of relevant human resources on the utilization of GIS and RS. The Training was attended by 37 participants including junior fisheries officers and researchers from the AMSs who have the basic knowledge of and/or working on GIS and RS in fisheries and environment, resource person from Burapha University, Chanthaburi Campus in Thailand, and technical and support staff from the SEAFDEC Secretariat and TD.



*Regional Online Training Course on Geographic Information System (GIS) and Remote Sensing (RS) for Aquaculture*

Although one of the activities under this Project was the development of research cruise plan for research/training vessels of SEAFDEC and Member Countries, the research cruises planned for 2021 were not possible due to the COVID-19 situation. Nevertheless, in 2021, TD developed the cruise plans for Myanmar and Philippines, and these cruise plans are expected to be finalized in early 2022.

This Project also supported the conduct of research study on microplastics in the northern part of the Gulf of Thailand, and the analysis of which is in process. Moreover, the Project also supported the development of the Standard Operation Procedures (SOPs) for Evaluation of Artificial Reefs Installation to Enhance Marine Resources: Case Study of Fish Enhancing Devices (FEDs), which is expected to be published in 2023.

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

In 2021, SEAFDEC/MFRDMD continued to implement the regional project “**Fisheries Management Strategies for Pelagic Fish Resources in the Southeast Asian Region.**” The Project implementation covers the period from 2020 to 2024 with the aim of evaluating the pelagic fish resources in the Southeast Asian region in order 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 pelagic fish species in the region as well as a study of the life history of the species through age determination analysis. The Project has eight participating AMSs, namely: Brunei Darussalam, Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Thailand, and Viet Nam, with the responsibility of providing information and fish samples for the Project.

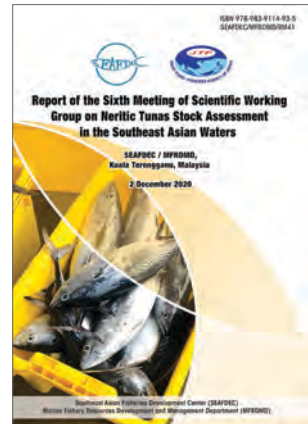
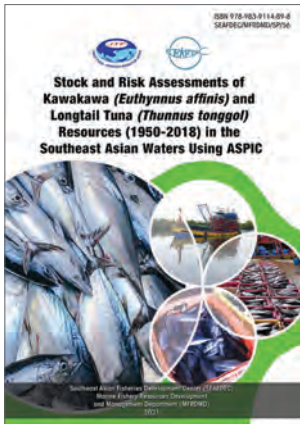
In 2021, under the activity on “Stock assessments and risks assessments for small pelagic fishes in the Southeast Asian region,” MFRDMD started gathering and compiling catch and effort data for the three selected small pelagic species/group, namely: *Rastrelliger kanagurta*, *Rastrelliger brachysoma*, and *Decapterus* spp., by sending out a set of questionnaires to obtain catch and effort data from the participating AMSS.

Under another activity on “Stock assessments and risk assessments for major neritic tuna species in the Southeast Asian region,” MFRDMD organized the “Workshop on Seerfish in the Eastern Indian Ocean and Western Pacific Ocean using ASPIC in collaboration with the Department of Fisheries (DOF) Malaysia” on 19–23 December 2021. The Workshop was organized in Kuala Terengganu, Malaysia with the objectives to: 1) train the participants from MFRDMD and members of the Scientific Working Group for Stock Assessment on Neritic Tunas (SWG-Neritic Tunas) from the DOF Malaysia on CPUE standardization and stock assessment analysis using ASPIC, Kobe plot (stock status trajectory) decision-making tool for management, and other relevant programs; and 2) conduct stock and risk assessments for two seerfish species, *i.e.* narrow-barred Spanish mackerel (*Scomberomorus commerson*) and Indo-Pacific king mackerel (*Scomberomorus guttatus*) in the Eastern Indian Ocean and Western Pacific Ocean. However, due to the COVID-19 situation restricting international travels, this practical workshop was organized with participants only from Malaysia and was attended by officials from MFRDMD and members of the SWG-Neritic Tunas from the DOF Malaysia. The workshop made use of the data from the DOF Malaysia (*i.e.* landing data and catch and effort data) as well as other landing data from IOTC and FAO FishStat J. During the Workshop, the participants were trained to use the specific software for stock assessment such as CPUE standardization, ASPIC, Kobe Plot I-II, and risk assessment. Based on the initial data analysis, the results showed that narrow-barred Spanish mackerel was overexploited in the Eastern Indian Ocean while still in a safe situation in the Western Pacific Ocean. On the contrary, the Indo-Pacific king mackerel was in an overexploited situation in the Eastern Indian Ocean but in a safe situation in the Western Pacific Ocean.



*Workshop on Seerfish in Eastern Indian Ocean and Wesern Pacific Ocean using ASPIC  
in Collaboration with DOF Malaysia  
(19–23 December 2021, Kuala Terengganu, Malaysia)*

In 2021, MFRDMD also published the “Stock and Risk Assessments of Kawakawa (*Euthynnus affinis*) and Longtail Tuna (*Thunnus tonggol*) Resources (1950–2018) in the Southeast Asian Waters using ASPIC.” The report is available online at the SEAFDEC/MFRDMD repository (<http://repository.seafdec.org.my/handle/20.500.12561/1508>) and at the IOTC website (<http://www.iotc.org/documents/WPNT/11/INF01>). Moreover, MFRDMD also published the reports of two meetings organized in 2020, *i.e.* Core Expert Meeting on Fisheries Management Strategies for Pelagic Fish Resources in the Southeast Asian Region organized on 24 November 2020 and 6<sup>th</sup> Meeting of the Scientific Working Group (SWG) on Neritic Tuna Stock Assessment in the Southeast Asian Waters organized on 2 December 2020.



Publications for 2021 from the JTFVI Phase II project “Fisheries Management Strategies for Pelagic Fish Resources in The Southeast Asian Region”

Under another activity on the “Clarification of the stock structure of one neritic tuna species in the Southeast Asian Region,” MFRDMD is in the progress of analyzing DNA samples in the MFRDMD laboratory. During the past study in 2016–2018, a total of 710 kawakawa (*Euthynnus affinis*) samples were collected from 15 different locations in Southeast Asia. From all these samples collected, 390 DNA samples were successfully sequenced. These DNA samples were analyzed using mitochondrial DNA d-loop region.



Gel electrophoresis of DNA genomic extraction product



In addition, MFRDMD also resumed the activity on “Life history study for major neritic tuna species in the Southeast Asian region” focusing on the analysis of otolith of kawakawa to determine the age. The monthly collection of fish samples from the east coast of Peninsular Malaysia was conducted from January to December 2020; however, the samples were not collected during November and December 2020 due to the monsoon season. A total of 370 otoliths of kawakawa samples from January to October 2020 were analyzed. Results showed that the age of kawakawa with 240–640 mm fork length ranged from one to seven years, with 29 % of the samples being about four years old, and 27 % of the samples being five years old. Furthermore, the gonad stage and stomach content of the samples were also analyzed to measure the gonadosomatic index and determine the spawning season of kawakawa. In 2021, the number of samples collected each month was increased to ensure sufficient samples for analysis. From February 2021 to December 2021, MFRDMD collected 649 samples of kawakawa for otolith analysis. Until April 2021, 57 samples were analyzed and it was found that the age of the kawakawa samples ranged from two to seven years. The analysis of the otoliths will be continued in 2022.



*Analysis of otolith of kawakawa (E. affinis) from the east coast of Peninsular Malaysia*

## 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. The contribution of inland fisheries to the rural communities is also significant in terms of poverty alleviation, food security, and nutritional well-being. Considering that the sustainability of inland capture fisheries depends on the quality of aquatic habitats and ecosystems, the need to ensure the sustainability of inland capture fisheries should be recognized not only by the fisheries but also by other relevant sectors. One of the main tasks of IFRDMD is, therefore, to undertake a comprehensive assessment of inland fisheries for sustainability. In 2021, IFRDMD continued to implement the regional project “**Management Scheme of Inland Fisheries in the Southeast Asian Region**,” which covers the period from 2020 to 2024. The Project comprises activities that dovetail 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 to determine biological characteristics.

Under the activity on monitoring and evaluation program for Special Area for Conservation and Fish *Refugia* (SPECTRA) system which is an artificial rehabilitation ecosystem model in a floodplain area that looks like *lebung*/pond functioning as protection or fishery sanctuary area, IFRDMD has set up the pilot model of SPECTRA in 2020 in South Sumatera Province, Indonesia. In 2021, the IFRDMD staff continued to monitor and record water quality parameters, collect data on fish diversity, and conduct preliminary research on gender at the site. The results showed that the dissolved oxygen and pH were low as the model is located in the floodplain area; however, the group of swamp fish (blackfish) with additional breathing apparatus that allows them to uptake oxygen directly from the water were adaptable to these conditions.

Furthermore, recognizing the importance of fish for nutrition and food security, both directly for the provision of micronutrient-dense lean protein and indirectly as income sources and opportunities for women's empowerment, IFRDMD is rearing several economic species of blackfish, *i.e.* three spot gourami (*Trichopodus trichopterus*), snakeskin gourami (*Trichogaster pectoralis*), catfish (*Clarias sp.*), kissing gourami (*Helostoma temminckii*), climbing perch (*Anabas testudineus*), and snakehead (*Channa striata*). The results of the proximate analysis showed that the three spot gourami had the highest protein content, while snakeskin gourami had the highest lipid content.

For the preliminary study on gender, IFRDMD selected a village close to the SPECTRA pilot model. It was found that men work mainly as fishers and farmers, while women produce fish products, *i.e.* *kemplang* (fish cracker), *kerupuk* (fish cracker), salted fish, fish meat, and *bekasam* (fermented fish) from blackfish. Unfortunately, the fish products were only traded at the local market since the women were unable to do the marketing.



*Interview for the preliminary research on gender issues*

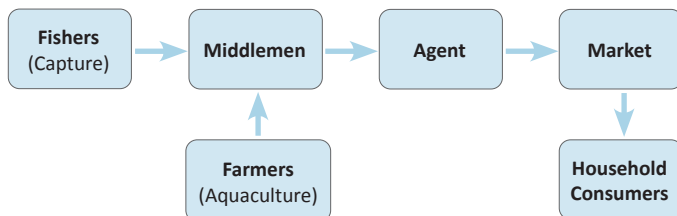
For the peatland area which is another important inland habitat, IFRDMD conducted a survey in Riau and Central Kalimantan, Indonesia to promote and implement SPECTRA system in both areas. The survey team also investigated the local wisdom of fish and habitat conservation that are still practiced up to the present.



Canal and fisher in peatland area

For the data collection, IFRDMD hired enumerators to record the data on daily fish production and length and weight of fish caught by using traps in the SPECTRA system. The groups of aquatic species identified in the SPECTRA system include snakehead (*Channa striata*), labyrinth (*Helostoma temminckii*, *Trichopodus trichopterus*, *Betta sp.*, *Trichogaster pectoralis*), barb (*Puntius sp.*, *Belontia haselti*, *Rasbora sp.*), and crustaceans (*Macrobrachium sp.*). The major fish species caught were *Rasbora sp.*, *Belontia hasselti*, and *Puntius sp.* which belong to the barb group.

In the Kampar River in Riau, enumerators were also hired to gather data on daily activities of fishers, e.g. fishing time, fishing location, types and number of fishing gears, fish species, total catch, total catch per species, and fish price. The enumerators also recorded biological data (length and weight) from 60 fish samples. For the recording of the daily fish marketing, two middlemen were hired to record the species, the number of fish sold, and the price to understand the fish value chain. At this area, the community's demand for freshwater fish is high to fulfill the cheap protein. Besides, freshwater fish commodities are essential for rural people as a source of income. However, the high demand could become a threat and cause the overexploitation of inland fishery resources.



Value chain of the inland fisheries at the study site in Riau, Indonesia

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***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, and the results of which could be used in preparing appropriate planning and management strategies for the sustainable utilization of resources. These technologies had 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 resources. Since 2019, the project **“Strengthening the Effective Management of Inland Fisheries and Aquaculture in AMSs with GIS and RS Technology”** was implemented by the SEAFDEC Secretariat in collaboration with TD with the support from the Japan-ASEAN Integration Fund (JAIF). The Project was aimed at developing the methods for monitoring inland fisheries and aquaculture using the GIS and RS technologies and investigating the relationship between the amount of catch and environmental data through GIS mapping. There are five project pilot sites in the AMSs, namely: 1) Tonle Sap Great Lake in Cambodia, 2) Sentarum Lake in Indonesia, 3) Nam Ngum Reservoir in Lao PDR, 4) Akwi In in Myanmar, and 5) Bangrakum floodplain in Thailand for the implementation of activities, *i.e.*: 1) collection of catch using logbook of fishers in the five pilot sites; 2) collection of environmental data from a satellite; 3) analysis of the relationship between catch data and environmental factors. The original duration of this Project was until June 2020; however, considering that the activities could not be implemented as planned due to the restrictions caused by the COVID-19 pandemic, the completion of the Project was rescheduled to December 2021, and extended again until December 2022.

On 23 December 2021, an internal meeting was organized among the members of the Project team to update the progress of activities until 2021 and forecast the activities until the end of the Project, plan the activities for 2022, and discuss the financial status of the Project. Up to the end of 2021, historical satellite data from 2009 to 2018 for the five Project pilot sites have already been downloaded from the website of the Japan Aerospace Exploration Agency (JAXA) and other websites for various environmental parameters, *i.e.* rainfall, lake surface temperature, Chlorophyll a, area, and depth; while single year data were calculated from April 2019 to July 2020. As the collection of catch data from the five pilot sites has already been completed, the Project has proceeded with multivariate statistical analysis to clarify the relationship between catch data and satellite data, and the analysis would be continued and completed in 2022.

For the remaining implementation period of the Project, the activities would focus on the development of an analysis manual for using GIS mapping/remote sensing techniques and the Project final report. Moreover, the Project also plans to organize a workshop on techniques for analyzing catch data and environmental data using GIS mapping/RS technology in 2022 to disseminate the technology and analytical methods to the AMSs.

## ***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 implemented by TD starting 2018 with support from the United States Department of Interior (US-DOI) and 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.

The Project was aimed at the construction of one fish passage each in Cambodia, Thailand, and Viet Nam with the duration from 2018 until September 2020. In 2019, the Project had successfully completed the construction of Kbal Hong fish passage in Cambodia, while the construction in Hany Wang Chang Weir in Udon Thani Province, Thailand had been completed in 2020. On 22 June 2021, the Project transferred the ownership and rights over the fishway in Hany Wang Chang Weir from the US-DOI International Technical Assistance Program to the Sangkom Sub-district Municipality.



*Fishway in Hany Wang  
Chang Weir constructed at  
in Sangkom Sub-district,  
Thailand*

As for the project site in Viet Nam, the construction of the demonstration fishway at Ea Tul weir in Đắc Lac Province was undertaken in 2021. Two meetings were organized by the Đắc Lac Department of Agriculture & Rural Development (DARD) with the local government, other related authorities, and residents to obtain their agreement on the construction at the site. At the end of 2021, most of the construction has been successfully completed except the direction flow channel along the dam which could not be undertaken due to continuous water flow during the construction period; however, it is expected that the construction would be completed by February 2022.

Moreover, under the same Project, the US-DOI also agreed to provide support for the construction of three additional demonstration fishways in Cambodia. To ensure the smooth operation of the activities, photographic surveys were conducted during January–February 2021 at three potential sites, namely: 1) Sambour Dam, 2) Srei Snom Spillway, and 3) Makak Spillway in Siem Reap Province. The surveys were led by a local survey team with technical indications from the Australian Fish Passage Service. Based on the survey results, the Sambor Dam and the Srei Snom Spillway were selected for the construction of demonstration fishways, and the construction workplans were finalized in August 2021.

For another site at Makak Spillway, the report of the photographic survey on profile and contour line of Makak Spillway was prepared and used to support fishway design which was submitted on 30 July 2021 for approval by the Project. However, the actual construction of the demonstration fishways in Cambodia would be subject to several factors, e.g. rain and flood, COVID-19 situation, which may impede the contractors and local workers from entering into the sites; while officials in charge of the construction of fishways in Cambodia and the engineer from the Australian Fish Passage Service would also discuss and review the design and size of the fishways, taking consideration the remaining period of the Project implementation.



*Photographic survey of Makak Spillway*

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

The national development plan in a number of countries in Southeast Asia is to construct infrastructure for dams in inland waters as the priorities of the governments are aligned with expanding the connectivity to boost economic growth, alleviate poverty, enhance crop productivity, ensure water availability, and provide electricity. Indonesia has exemplified this development plan, particularly in Java and Sumatra. At present, the construction of dams is intensive in the country. Reports showed that more than 3,000 dams and weirs have been built, and the Government of Indonesia continued to build 65 large dams from 2019 to 2024. The construction of weirs in Indonesia is primarily intended for agricultural irrigation; although recently, weirs have been also used for flood prevention. Nevertheless, weirs could also have adverse effects such as blocking the migration routes of some fishes, leading to the disruption of life cycle of such fishes that cannot swim upstream/downstream to spawn as well as possible disappearance of some fish species. Nonetheless, such predicaments had been addressed as some weir construction now comes with fish passes that provide entrance and exit for fishes to migrate and complete their life cycles.

To contribute to such development, IFRDMD in 2021 continued the implementation of 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), in collaboration with the Charles Sturt University (CSU). The 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 committed to lead and develop a national fishway blueprint and benchmark in Indonesia; while the AWP team from Indonesia compiled the blueprint fishway with the CSU team.

The Caringin Weir at the Cibareno River was the first model for the construction of fishway. The weir is located at the upstream river which is a remote area and difficult to reach. The construction of the Caringin Weir started in 2021 and will be finished at the end of 2021 without a fishway. Nevertheless, considering the local ecosystem where fish biodiversity and hydrological aspects are the main requirements, the appropriate fish ladder design and construction were envisaged to be necessary.



*Caringin Weir in the Cibareno River, Sukabumi, Indonesia*

At another site in Martapura, OKU Timur, South Sumatra, Indonesia, IFRDMD visited the Department of Fisheries and Livestock OKU Timur and interviewed the local people who live around the Perjaya Weir which is one of the largest water infrastructures that have been developed in Indonesia and supports the agriculture sector of South Sumatra. Aside from being utilized for irrigation system, the Perjaya Weir has recently been opened for recreational purposes attracting local and non-local tourists, especially during national holidays. Surrounding the weir are many stalls offering a variety of fruits and vegetables as well as fish stands where fishers sell fresh native fish caught from the river, such as giant featherback (*Chitala lopis*), Hampala barb (*Hampala macrolepidota*), snakehead (*Channa striata*), “seluang” (*Rasbora* sp.), catfish (*Hemibargus nemurus*), and others. Nevertheless, the fish pass constructed in the Perjaya Weir has weaknesses as fishes have difficulties in swimming upstream and downstream as the exit gate is very close to the irrigation tunnel with strong water current, and the baffles were designed for salmon and not for the native fishes of Indonesia to pass. Furthermore, IFRDMD conducted surveys and training in community around the Perjaya Weir to promote the fish passage with the campaign #SaveOurBiodiversity. The team also posts the content on social media (Instagram: @seafdecifrdmd) to enhance people’s awareness and knowledge of fish passage and biodiversity.



*Interviewing the community living around the Perjaya Weir*

Another weir is the Sulawena Weir located in Poso, Indonesia. Although there is an existing fish pass, it was designed only for the upstream migration of fishes. In such a situation, eels while migrating downstream will have to swim near the turbine in the middle of the river, risking their safety and survival.



*Perjaya Weir, Martapura, South Sumatra (above) and Sulawena Weir, Poso, Central Sulawesi (below) in Indonesia*

Besides, IFRDMD organized the Training for Research Assistants with the purpose of obtaining appropriate socioeconomic data to support the sustainability of fishery resources in the river. The training was held on 22–24 February 2021 in Palembang, Indonesia, and was attended by 30 participants including IFRDMD staff and eight research assistant candidates. In this training, explanations were made on the river basin in Sumatera, differences between weir and dam, and fish ladder. Another workshop “Water Resources Management to Secure Aquatic Biodiversity for Sustainable Development” was held for sharing information among the officers of the Ministry of Marine Affairs and Fisheries and the Ministry of Public Works and Housing Water Resources Management of Indonesia. The



*Workshop to secure aquatic biodiversity for sustainable development*



Workshop which was aimed at securing aquatic biodiversity for sustainable development in Palembang, Indonesia was attended by 34 participants consisting of researchers, academics, officers, fisheries extension staff, and experts.

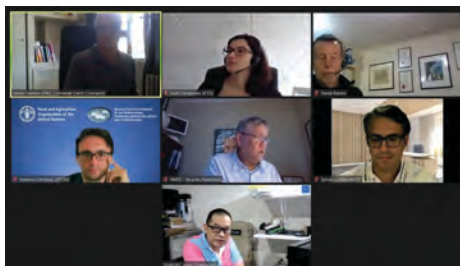
There are multiple challenges in designing effective fish passes, especially concerning the large-scale fish passes, migration of large species, migration peaks with high biomass, and high diversity of species, all constituting different requirements. Nonetheless, appropriate fish pass solutions should be able to provide multiple migration corridors along the riverbed, in mid-channel sections, along the shoreline, within the mid-water column, and at the surface.

### **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 it 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 the 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 AMSs to SEAFDEC since 2008. Nonetheless, the recent developments that continue to take place, especially with respect to the new standards established by the Coordinating Working Party (CWP) on Fishery Statistics, call for further harmonization of the Regional Framework. Therefore, the project “**Harmonization and Enhancing the Utilization of Fishery Statistics and Information**” was implemented by the SEAFDEC Secretariat covering the period from 2020 to 2024. The goal of Project is to facilitate 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 2021, 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 situation of fishery statistics of the countries in the region, representatives from the SEAFDEC Secretariat and TD attended the Coordinating Working Party (CWP) Task Group Meeting on Catch Concept and Fishing Effort (6 July 2021, online meeting), FIRM Technical Working Group on the Global Record of Stock and Fisheries (30 September and 1 October 2021), 12<sup>th</sup> FIRM Steering Committee (18–21 October 2021), and 27<sup>th</sup> CWP Intersessional Meeting (2–5 November 2021, online meeting).



*Coordinating Working Party (CWP) Task Group Meeting on Catch Concept and Fishing Effort (6 July 2021, online)*



*FIRM Technical Working Group on the Global Record of Stock and Fisheries (30 September and 1 October 2021, online)*

Another activity implemented this year is the revision of the Regional Framework for Fishery Statistics for Southeast Asia. SEAFDEC organized the “First Regional Technical Consultation on Fishery Statistics and Information in Southeast Asia” on 21–22 September 2021 where the discussion focused on the revision of the Regional Framework for Fishery Statistics of Southeast Asia in the part of the Explanatory Notes, inclusion of statistics on fish processing and statistics on fish trade (export and import) for regional compilation, overall workplan for revising the Regional Framework, as well as update on the progress made and difficulties faced by the AMSs in the reporting of fishery statistics.

Under another Project component on the preparation of the publication “Southeast Asian State of Fisheries and Aquaculture” or SEASOFIA 2022, SEAFDEC conducted the two “Inter-Departmental Consultations on Preparation of SEASOFIA 2022” in 2020 to finalize the outline and scope of topics to be prepared by the respective Departments as their inputs for the publication. In 2021, the SEAFDEC Secretariat and Departments proceeded in the preparation of article inputs based on the agreed outline, while additional inputs were also provided by the respective AMSs through the set of questionnaires developed by SEAFDEC. Moreover, SEAFDEC organized the “Third Inter-Departmental Consultation on Preparation of SEASOFIA 2022” on 18 and 20 October 2021 to finalize the draft articles for SEASOFIA 2022 and the final draft publication was submitted to the 43<sup>rd</sup> Meeting of the SEAFDEC Program Committee in 2021.



*First Regional Technical Consultation on Fishery Statistics and Information in Southeast Asia (21-22 September 2021, online)*



*Third Inter-Departmental Consultation on Preparation of SEASOFIA 2022 (18 and 20 October 2021, online)*

It should be also noted that this Project serves as a platform to disseminate the outputs, outcomes, and results of the various projects implemented by SEAFDEC. In 2021, 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 2019” 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 being prepared for publication and dissemination in early 2022.



*SEAFDEC Special Publication “Fish for the People” Volume 19 No. 1–3*

## 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***

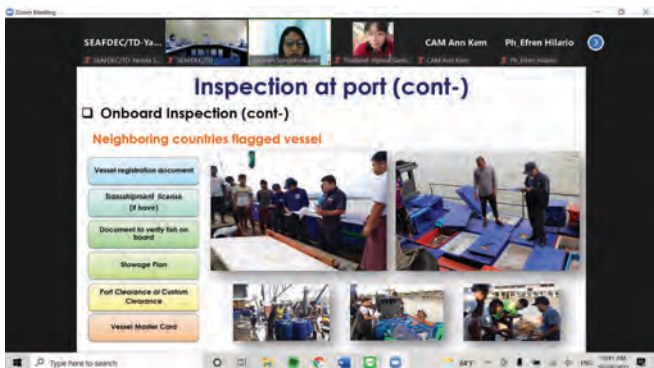
In order to address the concerns on illegal, unreported and unregulated (IUU) fishing in the Southeast Asian region, SEAFDEC has implemented a number of programs and projects to develop regional frameworks and tools to support the actions of the AMSs in combating IUU fishing. In sustaining such efforts, TD continued to implement the project **“Strengthening Regional Cooperation and Enhancing National Capacities to Eliminate IUU Fishing in Southeast Asia.”** With the duration from 2020 to 2024 and 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.

On the RFVR Database for vessels 24 meters in length and over, TD moved forward in facilitating the discussion among the AMSs on keying in of data by the respective countries during the “Teleworkshop on Development and Improvement of Regional Fishing Vessels Record (RFVR) for Combating IUU fishing in the Southeast Asia” organized from 28 to 30 September 2021 through the online platform. Participated in by the RFVR national focal points and fisheries officers from the AMSs, the Workshop discussed and exchanged updated information on vessel registration and fishing license, and the implementation of activities to combat IUU fishing among the AMSs, as well as introduced and discussed the new template/format of CSV/Excel file for the AMSs to upload the key data elements (KDEs) to the RFVR Database by themselves. Based on the new template/format provided, the AMSs were able to update information in the RFVR Database starting 1 November 2021.

Under another component on the strengthening of national capacities in the implementation of PSM and MCS, in 2021, TD continued providing assistance on capacity building on PSM implementation to the AMSs by organizing the “Regional Training on Port State Measures implementation for Inspectors in Southeast Asia” on 26–29 October 2021 through the online platform. This Training was conducted with resource persons from partner organizations, *i.e.* Food and Agriculture Organization of the United Nations (FAO), U.S. National Oceanic and Atmospheric Administration (NOAA), and Department of Fisheries Thailand; and was attended by officers from the AMSs who are engaged in the implementation of the PSM and/or port control activities at the inspection level. Through this Training, the AMSs shared the current situation of PSMA in their respective countries, while information on the implementation of PSM inspection was also shared by the respective partner organizations. In the end, the participants understood the implementation of PSM and enhanced their knowledge, skill, and experience on inspection to support PSM and port control implementation through further strengthening of regional cooperation to support the implementation of PSM in Southeast Asia.

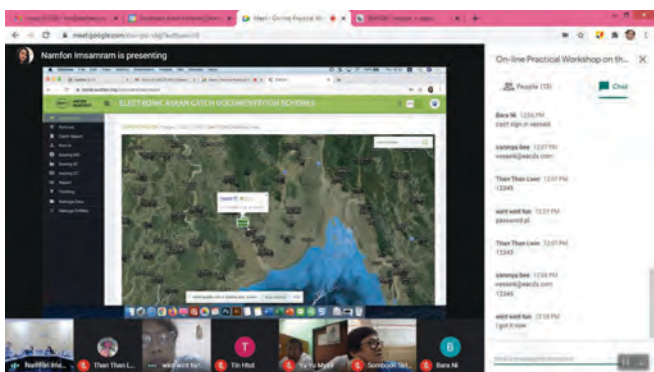


*Teleworkshop on Development and Improvement of Regional Fishing Vessels Record (RFVR) for Combating IUU fishing in Southeast Asia (28–30 September 2021, online meeting)*

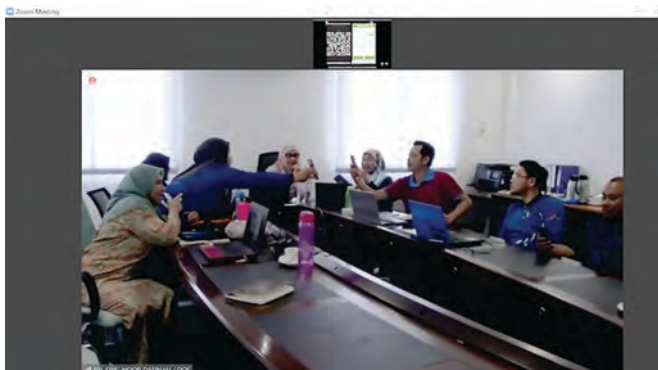


*Regional Training on Port State Measures implementation for Inspectors in Southeast Asia in collaboration with FAO, NOAA, and Department of Fisheries Thailand (26–29 October 2021, online meeting)*

Moreover, under the component on advancing the promotion of the eACDS, TD conducted a series of “Online Practical Workshop on the Use of eACDS Application Version 2” for the participating countries, namely: Myanmar on 21–22 January 2021, Malaysia on 24–25 February 2021, Brunei Darussalam on 30 March–1 April 2021, and Viet Nam on 7–9 April 2021. The aim of the Workshop was to enhance the participants’ understanding of the eACDS application and to encourage the trial usage of eACDS application by the respective AMs in the future. The next process for this component would be the transferring of the application to the respective participating countries.



*Online Training on the Use of eACDS Application Version 2 organized for Myanmar on 21–22 January 2021*



*Online Training on the Use of eACDS Application Version 2 in Brunei Darussalam on 30 March–1 April 2021*

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

### ***Small-scale Fisheries Management for Better Livelihood and Fisheries Resources***

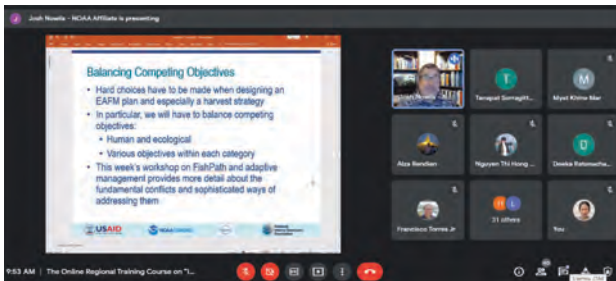
For over a decade, SEAFDEC has been promoting the implementation of the concept ecosystem approach to fisheries management (EAFM) in the AMSs through human resource development and pilot implementation at selected project sites. Starting 2020, the initiative has been sustained by TD through its project “**Small-scale Fisheries Management for Better Livelihood and Fisheries Resources.**” To be implemented from 2020 to 2024, this Project comprises three main components for different outputs, namely: 1) Implementation of the EAFM in the pilot learning sites; 2) Capability development in the implementation of SSF guidelines for improving the livelihood and well-being of small-scale fishers; and 3) Further promotion of the gender integration and empowerment in sustainable fisheries management in SEA and gender empowerment to promote alternative livelihood.

Under the ***first component***, TD continued its efforts in strengthening human resources development and further promoting the EAFM concept; and the lessons learned based on the application of the EAFM would be further shared and used for developing regional recommendations for effective implementation of the EAFM concept in Southeast Asia. In 2021, TD conducted a series of regional training courses through the online platform. The “Online Regional Training on Management Tools for the Ecosystem Approach to Fisheries Management” was organized on 23–27 August 2021 to build up the understanding of the AMSs of the appropriate fisheries management tools that could be applied in addressing the issues and problems. Subsequently, on 5–8 October 2021, TD with support from the resource persons from the NOAA also organized the “Online Training on Implementing Adaptive Fisheries Management and the Use of the Fish Path Decision Support Tool.” This training was aimed at building the capacity of the officers from the AMSs to implement FishPath—an online decision support tool that streamlines the process of identifying feasible options for the three central components of a harvest strategy, *i.e.* data collection, stock assessment, and management measures—as adaptive fisheries management measures that could be applied in the region. For activities at the EAFM pilot learning sites, *i.e.* Cambodia, Myanmar, and Thailand, TD conducted the “Online Regional Meeting on the EAFM Training Results and

the EAFM Implementation in the Learning Site” on 20 July 2021, and came up with a set of suggestions to promote and adopt the EAFM concept in the Southeast Asian countries. Subsequently, two “Onsite Workshops for the Development of EAFM plan for Tonle Sap Lake, Cambodia” were conducted by the EAFM focal points from Cambodia on 30 November 2021 and 10 December 2021, respectively.



*Online Regional Training on Management Tools for the Ecosystem Approach to Fisheries Management on 23–27 August 2021*



*Online Training on Implementing Adaptive Fisheries Management and the Use of the Fish Path Decision Support Tool on 5–8 October 2021*



*Onsite Workshops to Develop EAFM Plan for Tonle Sap Lake, Cambodia*

Under the **second component**, TD carried out the study on the status of fisheries socioeconomic assistance particularly through microfinance, credit, and insurance in Krabi Province, Thailand which is in line with the SSF Guidelines. The meeting workshop was conducted on 24–26 March 2021 to clarify the questionnaire and to train the enumerators for data collection. Subsequently, the baseline socioeconomic survey was conducted in Krabi Province from 29 March to 9 April 2021. The baseline information was used to develop the fisheries management plan in line with the EAFM concept during the “SEAFDEC Workshop on Developing Fisheries Management Plan for Eight Districts in Krabi Province, Thailand” from 14 to 16 December 2021. The Workshop involved key stakeholders from the eight districts in Krabi Province to formulate the fisheries management plan toward effective

management of fishery resources and improvement of the livelihoods of small-scale fishers in the Province, which was subsequently handed over to the Governor of Krabi Province.

TD also conducted pilot activity in promoting fishing community products and enhancing market accessibility at pilot sites in supporting the implementation of the SSF Guidelines with a view of improving the capacity of the fishing community in product distribution, marketing, and management in coastal and inland fisheries. The assessment studies on the status of fish processing products, *i.e.* production, distributions, market, and profitability of fisheries products, were conducted in Nam Oon Dam, Sakon Nakhon Province as the Project site for inland fisheries on 23–25 November 2021 and in Krabi Province as the Project site for coastal fisheries on 17–19 December 2021. The results of the studies were reported to the community to support the development of the business plan and marketing strategy by the respective fish processing groups. In addition, TD also organized the training for Fish Processing Group at Nam Oon Dam on 23–24 December 2021 to transfer knowledge and provide information on marketing strategy, as well as to provide training on the packaging of products that could strengthen their capacity for market accessibility. At the regional level, the “Regional Workshop on Effective Practice for Supporting the Livelihood and Well-being of Small-scale Fishers (SSF) in Southeast Asia” was organized by TD on 27–28 October 2021 to facilitate sharing of the lessons learned among the AMSs on successful and effective practices to support and improve livelihood including adaptations to the COVID-19 situation of small-scale fishers, and introduce the approaches to facilitate access to microfinance services.



*Development of the Fisheries Management Plan in Krabi Province, Thailand*



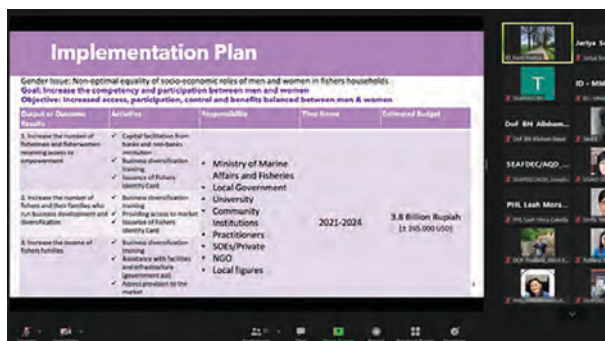
*Pilot activity in promoting fishing community products and marketing accessibility in Krabi Province, Thailand*



*Pilot activity in promoting fishing community products and marketing accessibility in Sakon Nakhon Province, Thailand*

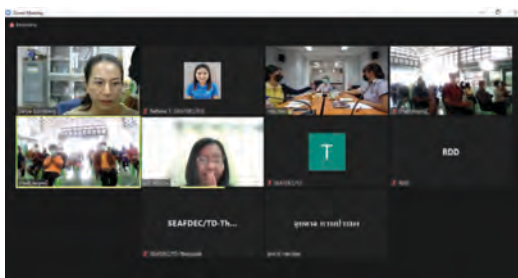


For the **third component**, capacity development activities on gender integration in SSF which includes fisheries management process and value chain were conducted in Thailand and Lao PDR in close cooperation with the Department of Fisheries of Thailand and the Department of Livestock and Fisheries of Lao PDR. Moreover, the “Regional Training on Gender on Equality and Equity in Integration in SSF in Southeast Asia” was organized from 28 to 30 September 2021. The objective of the Training was to impart and exchange knowledge, skills, and experiences on gender integration in fisheries projects to guide the project team in the respective countries in ensuring that they are using gender inclusive approaches to enhance human well-being in fisheries communities. The Training was attended by the representatives from the AMSS, namely: Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, and Thailand, as well as staff of the SEAFDEC Secretariat, AQD, IFRDMD, MFRDMD, and TD.



Regional Training on Gender on Equality and Equity in Integration in SSF in Southeast Asia on 28–30 September 2021

For the activities at the site level, in 2021, TD conducted studies on gender integration in fisheries management in Thailand at two Project sites, *i.e.* Buriram Province for inland fisheries and Rayong Province for marine fisheries. In Buri Ram Province, the data collection for gender integration in inland fisheries was conducted at Subsomboon Community on 1–5 March 2021; and this was followed by the data validation workshop on 20–22 September 2021 to report and recheck the results from the data analysis. From the study, it was found that while women and men participated in all activities of the Aquatic Animal Food Bank of Subsomboon Group, women mainly led the group from its establishment until the present. For Rayong Province, the study on gender integration in marine fisheries management was conducted on 11–22 October 2021. From the results, the roles of women and men in the fishers’ group were clear and equal on the domestic aspect. However, their roles



Data collection for gender integration in inland fisheries on 1–5 March 2021 (left) and data validation workshop on 20–22 September 2021 (right) at Subsomboon Community, Buri Ram Province

in fisheries activity were different, *i.e.* capture fisheries roles were carried out by men, while fish selling was mainly done by women. Nevertheless, they assisted each other in group activities based on their respective expertise. It was also found that the key factors for the success of the group management were the high level of participation and strong leadership of the group.



*Meeting with the fishing community for the study on gender integration in marine fisheries management in Rayong Province, Thailand on 11–22 October 2021*

Moreover, the Project also supported the conduct of monitoring and evaluation of gender integration at two Project sites in Lao PDR which were supported by the previous project of SEAFDEC on the promotion of CBRM and co-management. The monitoring and evaluation activities were conducted in Nam Xouang Province on 9–13 August 2021. From the monitoring, it was found that the fish processing activities could still be maintained by the community to produce their fish products depending on the demand from local consumers. In Khammoune Province, the monitoring and evaluation activities were conducted on 23–27 August 2021. It was found that the community in Khammoune Province decided to suspend the catfish culture due to the COVID-19 situation; however, they could still continue fish processing by using raw materials from natural resources.



*Monitoring and evaluation in Nam Xouang Province, Lao PDR on 9–13 August 2021*



*Monitoring and evaluation in Khammoune Province, Lao PDR on 23–27 August 2021*

## 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 the development and promotion of environment-friendly fishing gears and practices with a view of 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 2021, TD continued to sustain such efforts through its regional project “**Responsible Fishing Technology and Practice**,” with the duration from 2020 to 2024. Besides the development/promotion of environment-friendly fishing gears and practices, this Project would also promote the concept of low impact and fuel efficient (LIFE) fishing by applying appropriate fishery machinery onboard fishing vessels, improving onboard fish handling practices, and addressing the issues of abandoned, lost or otherwise discarded fishing gear (ALDFG). It is expected that such technological improvements through the Project would result in changes in the behavior of fishers to undertake fishing practices in a more responsible manner.

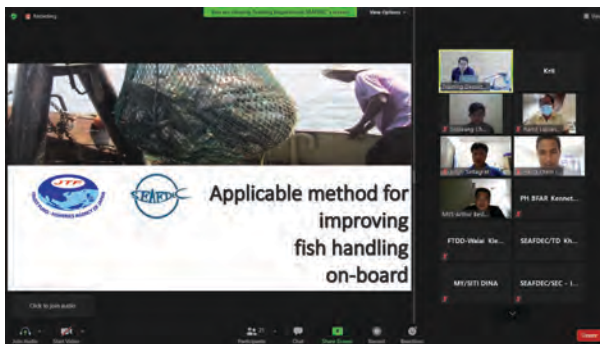
To facilitate the adoption of the concept of LIFE fishing, TD throughout the years has been undertaking a number of technological improvements, *e.g.* reduction of impacts from trawling to the seabed, improving methodology to collect information on ALDFG, promotion of fishing gear marking, and development of appropriate deck machinery and auxiliary devices onboard fishing vessels. Such improvements have led to changes in the behavior of fishers in fishing operations toward more responsible practices, lessened damages on the aquatic ecosystems, reduced emission of greenhouse gas and fuel costs, and better utilization of fishery resources in a more economical and sustainable manner. In the longer term, such improved fishing operations would result in the improved livelihood of fishers and fishing communities from sustainable utilization of fishery resources.

Based on such technical works, TD in 2021 conducted the “Online Regional Training Course of Deck Machineries and Hauling Devices to Reduce Manpower in Fishing Vessels and Enhance Safety in Fishing Operations” during 5–6 May 2021. The Training was attended by participants from the AMSs who are mechanics, technicians, and engineers. The aims of the Training were to enhance the understanding and capacity of the participants on the use of deck machinery and hauling devices, as well as in optimizing energy and safety at sea in capture fisheries and fishing fleets; and for them to apply the knowledge gained from this Training on their works when relevant and applicable in the future.

Moreover, TD also conducted the “Online Regional Training Course of Fish Handling Techniques Onboard Fishing Vessels” on 12–13 May 2021. This Training was attended by participants from the AMSs who have work relevant to fish handling. The aim of the Training was to enhance the technical knowledge and practical skills of the participants on reduction of post-harvest losses through improved awareness of good hygiene and onboard fish handling practices that are applicable for fishing fleets in the region.



*Online Regional Training Course on Deck Machineries and Hauling Devices to Reduce Manpower in Fishing Vessels and Enhance Safety in Fishing Operations on 5–6 May 2021*



*Online Regional Training Course of Fish Handling Techniques Onboard Fishing Vessels on 12–13 May 2021*

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

In addition to the aforementioned regional Project, TD also implemented its Departmental Program on **“Improvement of Fisheries Technology and Reduction of the Impact from Fishing Activities.”** This Program comprises three scopes of activities, namely: 1) Research and promotion of appropriate technologies and practices of fishing and marine engineering; 2) Study on the impact on fisheries resources, marine environments, social well-being, and livelihood from fishing activities; and 3) Database for fisheries management.

Under the first scope of activities, an expert from TD supported the DOF, Thailand to improve the midwater trawl net of the research vessel of the DOF, Thailand. In the past, all research vessels of the DOF, Thailand were installed with standard bottom trawl to support the conduct of demersal fishery resources survey. However, bottom trawl nets have limitations in investigating the abundance and distribution of small pelagic fishery resources, *e.g.* sardines, Indian mackerel, and Indo-Pacific mackerel, that are important for the region. The use of midwater trawl nets would therefore be more appropriate not only for the investigation of small pelagic fishery resources but also when it is operated in combination with a scientific echo sounder that could be equipped onboard the vessel.

In addition, to follow up the study undertaken in 2020 on the scientific echo sounder suitable for the M.V. SEAFDEC 2, TD in 2021 acquired and installed the scientific echo sounder SIMRAD EK-80 onboard the M.V. SEAFDEC 2. The scientific echo sounder is one of the most effective tools used by leading marine scientists and international research institutes in the conduct of the stock assessment. The split band echo sounder system

of SIMRAD EK-80 could be operated using a wide range of frequencies simultaneously from 10 kHz to 500 kHz which is an international standard for fish stock assessment, and the equipment could be operated in combination with the midwater trawl onboard the M.V. SEAFDEC 2 to investigate the abundance and distribution of the small pelagic fishery resources. The ability to apply the scientific echosounder SIMRAD EK-80 in combination with the midwater trawl operations is envisaged to be very useful for the SEAFDEC Member Countries requesting to use the M.V. SEAFDEC 2 in obtaining more accurate data on fishery resources to support better management of fisheries. SEAFDEC will continue to utilize the M.V. SEAFDEC 2 to support shipboard surveys to conduct stock assessments of small pelagic fishery resources for requesting Member Countries in the future.

TD also continued the conduct of research and development on the use of deck machinery to improve net hauling efficiency and reduce manpower in purse seine fishing operations. The improvement of deck machinery, *i.e.* installation of power block on a private purse seiner, NOR LARPRASERT 8 in Pattani Province, Thailand to serve as a prototype vessel which was undertaken in 2020, was continued and completed in 2021. The original Thai purse seine net (materials, design, and construction) was modified and improved to be more appropriate to the new auxiliary equipment on the deck, especially the power block and other deck machinery to support net hauling. It is expected that the use of the hauling devices in combination with a more appropriate purse seine net would enhance the fishing operation efficiency by reducing manpower and improve safety in the conduct of fishing operations onboard the purse seiner.

Moreover, considering that TD has recently acquired in 2020 a new multi-purpose training vessel M.V. PLALUNG, the technical support was extended through this Project in 2021, *i.e.* installing the V-shape otter board onboard the vessel. It is expected that the V-shape otter board would improve trawling operations and reduce the negative impacts from the ploughing of otter board through the seabed.

Under the second scope of activities, TD completed the conduct of research on the impacts of fishing activities on the social well-being of fishers in Krabi Province, Thailand. TD also promoted the use of fish handling techniques and labor-saving equipment at Baan Nai Nang in Krabi Province and enhanced awareness of fishers and community members on the importance of hygiene to the catch after harvest and during the sorting process. This activity was intended to supplement the activity on promoting the implementation of the EAFM concept in Krabi Province, Thailand (*see 1.5, sub-topic on Small-scale Fisheries Management for Better Livelihood and Fisheries Resources*). The Project also intended to support the conduct of case studies on improving the market access of small-scale fisheries in Thailand, however, this activity was canceled in 2021 due to the COVID-19 situation.

TD also conducted the study on the status and impacts from fishing operations on marine environment. The development of the publication “Scombrid Fish Larvae and Juvenile in Southeast Asia” was facilitated, and it is expected that the publication would be produced in 2022. However, the conduct of another study “Types and Amount of Debris on the Surface Layer of Chao Phraya River flowing into the Gulf of Thailand” was postponed to 2022.

Under the third scope of activities, the proposal for the development of a database system to compile fisheries socioeconomic information and small-scale fisheries studies was under preparation. The database system was aimed at facilitating TD researchers working on socioeconomics and small-scale fisheries to be able to manage and analyze the data collected from relevant projects and research studies, as well as to compile such data into reports or publications. Aiming to be user-friendly, the structure of the database system is expected to be finalized in 2022; and the data input into this database would be carried out in the following years.

### ***Fishing Technologies and Operation in Thailand and Options for Innovation and Improvement***

Under the Letter of Understanding between the FAO and SEAFDEC for the provision of “An assessment of the sustainability of currently used fishing technologies and operations in Thailand and options for innovation and improvements,” TD with support from the Project consultant gathered data and information from desk review on fishing technologies and operations currently undertaken in Thailand. Moreover, the survey on fishing technologies and cost and revenue from fishing operations was conducted in Rayong Province, Thailand. From such data collection, the Project came up with aggregated information on fishing technologies used, *i.e.* in otter board trawls, pair trawls, purse seines, gillnets, squid cast nets, and anchovy falling nets; while the cost and revenue from fishing operations using such technologies were analyzed. TD subsequently organized the “Stakeholders Meeting on the Fisheries Innovation Options in Thailand, Costs and Benefits and Expected Social, Economic and Environmental Returns” on 4 October 2021 in Rayong Province, Thailand to verify the results from the survey. As a result, TD would come up with the final assessment report on the sustainability of fishing technologies and operations in Thailand and options for innovation and improvements for submission to the FAO.

### ***Survey to Estimate Levels of Abandoned, Lost or otherwise Discarded Fishing Gear in Thailand Gillnet and Trap Fisheries***

Under the Letter of Understanding between the FAO and SEAFDEC for the provision of “Survey to estimate levels of abandoned, lost or otherwise discarded fishing gear in Thailand, gillnet and trap fisheries,” TD in collaboration with the DOF, Thailand conducted survey trials by using the FAO questionnaire to collect baseline information, *e.g.* spatial and temporal distribution of gear loss, causes, good practices to avoid fishing gear loss, end-of-life fishing gear management, and their perceptions on ALDFG from gillnets and traps (or pots); and developed a database to compile the data from the surveys in coastal provinces of Thailand as an example to estimate the levels of ALDFG. Due to the COVID-19 situation, however, only three surveys could be conducted in Krabi and Phang Nga Provinces, *i.e.* during 17–26 May 2021, 21 June–2 July 2021, and 4–8 October 2021. There was a total of 160 accomplished questionnaires and the results of which were analyzed and would be submitted to the FAO in early 2022. It was expected that through these trial surveys, the FAO questionnaire could be verified and finalized in order to support the collection of global baseline information on ALDFG, and the information collected through such questionnaire could be used to support the development of management actions to combat marine debris from ALDFG in the future.

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

### *Integration of habitats and fisheries management*

After the publication of the “Regional Guidelines for Responsible Fisheries in Southeast Asia” with the supplementary guidelines on fisheries *refugia* in 2006, the fisheries *refugia* approach has triggered common interest in the Southeast Asian region as a good area-based management practice that integrates several tools to achieve sustainable fisheries and conservation of critical habitats. The bottom-up approach from the local community to the national policy level was a hallmark. The acceptance from stakeholders of the establishment and operation of fisheries *refugia* together with the developed management frameworks for their *refugia* is critical to the Project’s success.

To promote the application of the 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 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 aim of the Project was 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. The four components of the Project include 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 this Project was originally scheduled to be completed at the end of 2020, the delay in signing



Target species identified in the fifteen fisheries refugia sites in Cambodia, Indonesia, Malaysia, Philippines, Thailand, and Viet Nam

of the Project LOA with some participating countries, *i.e.* Viet Nam and Indonesia, and the COVID-19 situation from late 2019 until 2020 necessitated the extension of this Project until mid-2023 with technical closure by the end of 2022.

As of 2021, 15 fisheries *refugia* sites were identified by six participating countries. Out of the six participating countries, Cambodia, Thailand, and Malaysia were the champions in establishing the fisheries *refugia* sites in their respective countries; while the other three countries also exerted their best efforts in speeding up their works to come up with the *refugia* sites as targeted. Unfortunately, due to the COVID-19 situation in 2021, all participating countries and the Project Coordinating Unit faced difficulties in implementing the Project activities, particularly technical activities at the sites; and working from home focusing on desk review was the only possible remaining option. Nevertheless, the progress of activities up to 2021 is summarized below.

For the progress made by **Cambodia** up to the present, the Government of Cambodia adopted two *refugia* sites in 2019, namely: 1) blue swimming crab *refugia* in Kep Province (covering 417 ha), and 2) Indo-Pacific mackerel *refugia* in Koh Kong Province (covering 1,283 ha), aiming to increase the stock of the two species as well as to conserve important habitats linked to these two species for their sustainable utilization. Towards achieving such outcomes, Cambodia adopted the 5-year Action Plan for Martine Fisheries Management Area and Management measures in Kep Province and the Strategic Plan for Fisheries Conservation and Management for 2020–2029. Cambodia also included the fisheries *refugia* framework in its revised fisheries law. While the Fisheries Administration (FiA) of Cambodia played the role in fisheries management and habitat conservations, the relevant local stakeholders including the fishing community, private sectors, civil society organizations (CSOs), and non-government organizations (NGOs) supported the proposed fishing closure for blue swimming crab in Kep Province from 1 May to 31 July 2021 and for short mackerel in Koh Kong Province from 1 December 2020 to 31 March 2021. The management measures were set to reduce 100 % of the fishing pressures during the spawning seasons to protect the recruitment of the blue swimming crab and short mackerel. Another *refugia* site for grouper in Kampot Province was accepted by all relevant stakeholders and the *refugia* boundary and management plan was proposed in December 2021.

For **Thailand**, two *refugia* boundaries and management plans were accepted through the stakeholders' consultations which were participated in by the representatives from the environment agency and more than 800 people from relevant fishing communities, CSOs, academes, and research institutions. These two *refugia* sites were: 1) blue swimming crab *refugia* in Surat Thani Province (covering 900 ha), and 2) short mackerel *refugia* in Trat Province (covering 154,600 ha). Both *refugia* sites were linked to coral reefs, seagrass, and mangrove habitats. To support the long-term management of these two *refugia* sites, the DOF, Thailand had reformed the law, regulation, and management plan to support the establishment and operation of fisheries *refugia*. Local people from seven Districts in Surat Thani Province and five Districts in Trat Province were engaged in the blue swimming crab *refugia* and short mackerel *refugia*, respectively; and showed the good attitude toward resources and habitat conservation for sustainable utilization. In Surat Thani Province, the stakeholders voted to support the proposed *refugia* boundary based on science-based



information and the management plan to prohibit specific fishing gears, namely: crab traps, crab gillnets with less than 3.0-inch mesh size, and all types of clam fishing that are operated in motorized vessels. In Trat Province, the stakeholders voted to support the *refugia* boundary and management plan to prohibit purse seiners and trawlers during the period from January to February every year. Overall, approximately 7 % of all fishing vessels (212 medium- and large-scale fishing vessels) operated in this area would be prohibited in Trat Province during this two-month period; while about 29 % of all fishing boats in Surat Thani Provinces would be prohibited.

In **Malaysia**, two *refugia* boundaries were defined based on science-based information and through national experts consultation, namely: 1) spiny lobster *refugia* in the East Johor waters (covering 140,000 ha) and 2) tiger prawn *refugia* in Kuala Baram Miri (covering 85,200 ha). Through socioeconomic surveys along the coast of these two sites, it was found that 88 % of fishers from the eight Towns in Johor and 69 % of fishers from the two towns in Miri, Sarawak supported the establishment of *refugia* sites for spiny lobster and tiger prawn, respectively. The DOF Malaysia was in its final process to consult and obtain acceptance from the relevant stakeholders for the proposed *refugia* boundary and management plan of both sites.

For the **Philippines**, the National Fisheries Research and Development Institution (NFRDI) was in the process of setting up the fisheries *refugia* boundary based on the local knowledge and science-based information from the three Project sites. Three tentative *refugia* boundaries were mapped out but had not been finalized yet. These include 1) *refugia* site for *Siganus fuscescens* in Bolinao, Pangasinan; 2) *refugia* site for *Caesio cunning* and *Decapterus maruadsi* in Coron, Palawan; and 3) *refugia* site for *Auxis thazard*, *Pterocaesio teselleta* and *Sardinella fimbriata* in Masinloc, Zambales. The local government units (LGUs), including the coastal community members and other stakeholders, have agreed and understood the importance of establishing fisheries *refugia* sites in these three areas. Their willingness could be reflected in the results of several committee meetings, on-site stakeholder consultations, among others organized during 2017–2021. While fishers had expressed their strong disagreement with the establishment of marine protected areas (MPAs) in their municipalities, through the workshops, they understood the differences and the boons of establishing fisheries *refugia* that could lead to more productive fish stock and sustainable utilization.

For **Viet Nam** and **Indonesia**, the two countries started the Project implementation only in mid-2019 when the contracts for Project initiatives were signed by the respective countries. The Project implementation in the respective countries was underway and the outcomes are expected to be achieved before the Project closure in December 2022. However, the conduct of activities in 2021 at the planned *refugia* sites was difficult due to the COVID-19 pandemic.

Overall, it is expected that approximately 400,000 ha of *refugia* boundaries would be established in the six participating countries before the Project technical closure in December 2022, which is higher than the target adopted by the Global Environmental Facility (GEF). The percentage in reduction of fishing pressures in the *refugia* areas during the periods that were critical to life cycles of the species of transboundary significance

would be analyzed accordingly. The Project had improved engagements and acceptance of stakeholders on the area-based approaches to fisheries management. More than 100 multistakeholders from various institutions and agencies had engaged in the process, not only from fisheries but also others, *e.g.* environment agencies, tourism departments, public organizations, navy, coastguard, NGOs, CSOs, academes, research institutions, local governments at the provincial and state levels, fishing communities, private sectors. As of 30 June 2021, the institutional capacity for the establishment of fisheries *refugia* has increased with the endorsement of the national policy, legal, and management plans by Cambodia and Thailand. The regional policy for the management of transboundary fish stock, *i.e.* Indo-Pacific mackerel, was adopted by the SEAFDEC Council and ASWGFi in 2021 as the ASEAN policy framework. Furthermore, access to Project information and results from the Project implementation was enhanced through the regional website and national web portals, which can lead to improved understanding of the status and trend of fisheries in Southeast Asia covering the South China Sea and Gulf of Thailand areas.

### ***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 (CoP) to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) including the last CoP-18 CITES in August 2019 in Geneva, Switzerland. It was also expected that sharks and rays would be among the aquatic species discussed at the coming CoP-19 CITES scheduled to be held in Panama City, Panama on 14–25 November 2022. There are currently five species of sawfishes listed in Appendix I, 39 species listed in Appendix II, and the family Potamotryonidae listed in Appendix III of CITES. The species listed in Appendix III are currently undergoing taxonomic revisions and the listed family includes both undescribed species and newly described species. 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 fulfill the requirements for NDFs and other management purposes, exporting countries should collect the species' landing, biological, socioeconomic, and trade data and prepare specific management plans for their conservation and sustainable utilization. To enable the AMSs to accommodate such requirements, their expertise on species identification and collection of data on landings and biology should be strengthened. Besides, information on the utilization of such species is also useful to enhance the understanding of the socioeconomic importance of the species.

In 2021, MFRDMD continued its five-year project “**Research for Enhancement of Sustainable Utilization and Management of Sharks and Rays in the Southeast Asian Region**” which runs from 2020 until 2024. The objectives of the Project are: 1) to develop capacity in taxonomy, including identification of new species/record and management of major shark species; 2) to confirm 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 3) to carry out socioeconomic studies in Northern Viet Nam, Western Myanmar, and Indonesia.

### *Specimen collection for the genetic population study of selected shark species*

In 2021, MFRDMD collaborated with the Department of Fisheries (DOF) of Malaysia in Perak State and Fisheries Research Institute Kampung Acheh (FRIKA) of Malaysia in conducting DNA sampling for three species of sharks, namely: *Carcharhinus sorrah*, *Chiloscyllium hasseltii*, and *Sphyrna lewini*. The fish samples were collected from Bagan Panchor and Hutan Melintang, Perak by the DOF Perak staff and stored at FRIKA until the research team from MFRDMD came for DNA collection on 5–7 April 2021. The specimens were brought back to MFRDMD and stored in the DNA Laboratory of MFRDMD for further analysis using the mitochondrial DNA D-loop region. The necessary tools and kits were purchased and the DNA analysis of samples is in progress.



*Collection of DNA specimen sample from  
Carcharhinus sorrah*



*Measuring the total length of  
Carcharhinus sorrah*

Moreover, MFRDMD also visited Lambor Kiri, Perak which is one of the areas where freshwater rays were reported to occur in the Perak River. Since 2016, MFRDMD had collected six specimens of *Fluvipterygion kittipongi* from the Perak River and adjacent rivers.



*Perak River, one of  
the areas where  
freshwater ray was  
reported to occur*

### *Landing data collection on sharks and rays by species*

Landing data collection on sharks and rays by species was conducted in Kota Kinabalu and Tawau, Sabah, Malaysia from January to December 2021. The objective of this study was to

obtain landing data and biology information on sharks and rays by species. The data were collected for at least 12 days every month from 1–3 vessels that were selected randomly on each day at the landing site. All sharks and rays were measured and weighted individually if the total number of the landed catch was less than 50 individuals per vessel; while a sub-sample of about 10–50 % of the total landed catch were measured if the total number of the landed catch was more than 50 individuals. **Table 1** shows that the landing of sharks and rays was higher in Kota Kinabalu than in Tawau, Sabah.

**Table 1.** Landing data on sharks and rays in Kota Kinabalu and Tawau, Sabah, Malaysia from January to December 2021

| Group                 | Kota Kinabalu  |  | Tawau   |  |
|-----------------------|--|--|---|--|
|                       | Sharks   | Rays   | Sharks  | Rays   |
| Number of species     | 20   | 28   | 2   | 7  |
| Total weight (kg)     | 6,827  | 19,938   | 165   | 900  |
| Catch composition (%) | 0.36   | 1.06   | 0.11  | 0.62   |
| Dominant species      | <i>Chiloscyllium punctatum</i> ,<br><i>Carcharhinus sorrah</i> ,<br><i>Chiloscyllium plagiosum</i> ,<br><i>Carcharhinus leucas</i> ,<br><i>Carcharhinus brevipinna</i> | <i>Neotrygon orientalis</i> ,<br><i>Maculabatis gerrardi</i> ,<br><i>Telatrygon zugei</i> ,<br><i>Pastinachus ater</i> ,<br><i>Rhinoptera jayakari</i> | <i>Sphyrna lewini</i> ,<br><i>Carcharhinus sorrah</i> | <i>Maculabatis gerrardi</i> ,<br><i>Taeniura lymma</i> ,<br><i>Neotrygon orientalis</i> ,<br><i>Gymnura zonura</i> |

In Tawau, Sabah, considering that the former enumerator was transferred to the new Department, a new enumerator was assigned for data collection. The online “Training Data Collection” was conducted on 26 June 2021 to train the new enumerator together with the other enumerators on standard operating procedures to collect landing data on sharks and rays. A total of seven participants attended this Training, including two enumerators from Tawau, two enumerators from Kota Kinabalu, one research officer from FRIKA, one fishery officer from Likas, Sabah, and one fishery officer from Johor Bharu, Johor.

#### *Workshop on Conservation of Sharks and Rays Through Parasites’ Perspective*

MFRDMD organized the “Workshop on Conservation of Sharks and Rays Through Parasites’ Perspective” on 1–2 December 2021 at the MFRDMD premises in Kuala Terengganu, Malaysia. The Workshop involved 17 participants comprising research officers, research assistants, laboratory assistants, and contractual staff. The lectures and practicals were delivered by three lecturers from the Faculty of Science and Marine Environment, Universiti Malaysia Terengganu (UMT).

The objective of the Workshop was to expose the participants to conservation of sharks and rays through parasites’ perspective. The theory of parasites of elasmobranch, microbiome of sharks and rays, and effects of parasites on the population of these groups

were explained to the participants. The participants were also trained and guided to dissect specimens, examine and screen parasites under a microscope, and identify and preserve parasites. Two species of sharks (*Carcharhinus sorrah* and *Sphyrna lewini*) and three species of rays (*Brevitrygon imbricata*, *Maculabatis gerrardi*, and *Neotrygon orientalis*) were used for parasite examination at this Workshop.

After the parasite examination, participants presented a list of parasites found in the specimens, including cestode, copepod, monogenean, and trypanorhyncha. All participants showed their interests in parasitology and determination to improve their skills in screening and identifying parasites in sharks and rays.



*Screening and identifying parasites under a microscope during the Workshop on Conservation of Sharks and Rays Through Parasites' Perspective on 1–2 December 2021 in Malaysia*

#### *Workshop on Landing Data Analysis of Sharks and Rays by Species to Determine Value of Maximum Sustainable Yield (MSY)*

MFRDMD organized the “Workshop on Landing Data Analysis of Sharks and Rays by Species to Determine Value of Maximum Sustainable Yield (MSY)” on 6–7 December 2021 in Kuala Terengganu, Malaysia. A lecturer from the Faculty of Fisheries and Food Science, Universiti Malaysia Terengganu was invited as a resource person to explain fish stock assessment. A total of 18 participants including research officers, research assistants, laboratory assistants, and contractual staff of MFRDMD participated in the Workshop. Most of the participants were involved in stock assessment and data analysis.

The objective of this Workshop was to master the method in determining MSY value using the Schaefer and Fox models from any form of dataset arrangement. The MSY value of a given fish stock is the highest possible annual catch that could be sustained over time. It is, therefore, crucial to make sure that the annual catch does not exceed the MSY level to sustain the stock.

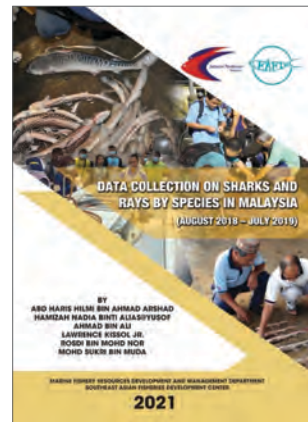
The dataset on shark and ray landings by species collected at SAFMA Jetty, Kota Kinabalu from 2018 until 2019 was used for this Workshop. A variety of dataset arrangements were given to all participants to determine MSY value using both models. Based on the observation during the Workshop, all participants showed improvement in their knowledge and skills in analyzing data to determine MSY value.



*Workshop on Landing Data Analysis of Sharks and Rays by Species to Determine Value of Maximum Sustainable Yield (MSY) on 6–7 December 2021 in Kuala Terengganu, Malaysia*

**Publications**

In 2021, MFRDMD published a number of publications on sharks and rays, namely: 1) Report of the First Core Expert Meeting on Research for Enhancement of Sustainable Utilization and Management of Sharks and Rays in the Southeast Asian Region (25 November 2020); 2) Report on Data Collection on Sharks and Rays by Species in Malaysia (August 2017–July 2018); and 3) Report on Data Collection on Sharks and Rays by Species in Malaysia (August 2018–July 2019).



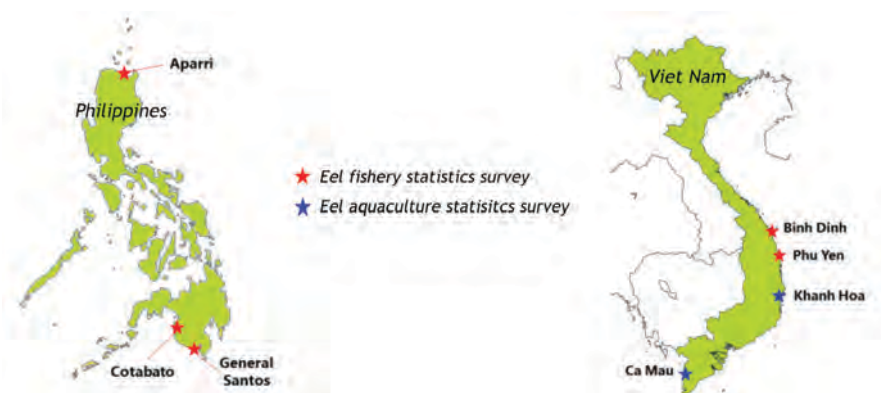
*Publications on sharks and rays published by MFRDMD in 2021*

### Conservation and management of catadromous eels

With the rapid decline of temperate eels and the listing of some anguillid eel species, *i.e.*, *Anguilla anguilla* and *A. japonica* in the CITES Appendices, the market value of tropical eels has risen during recent years. In view of the sustainable development of eel stocks in the Southeast Asian region, little information is available, but it is necessary to obtain a better understanding of the status, biology, and life cycle of eel stocks. To promote sustainable management and utilization of anguillid eel fishery resources in the region, SEAFDEC carried out two regional projects, namely: “**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.**”

The Project “**Development of Stock Assessment Methods and Strengthening of Resources Management Measures for Tropical Anguillid Eel in Southeast Asia**” was implemented by the SEAFDEC Secretariat in collaboration with IFRDMD with the support from the Japan-ASEAN Integration Fund (JAIF). The Project aims to collect the catch data and biological/ecological information for the estimation of eel stocks and to develop mathematical/statistical methods for estimating tropical anguillid eel resources. The original Project period was from 2020 to 2022, however, some planned activities could not be carried out due to the COVID-19 pandemic; therefore, the Project was extended until January 2023.

In 2021, four main activities were conducted, *i.e.* 1) eel statistics survey, 2) eel catch sample survey, 3) DNA survey, and 4) environmental DNA. On the eel statistics survey, a series of online meetings were convened with Philippines and Viet Nam in December to discuss the eel statistics survey manual and scheme. In the Philippines, the eel fishery statistics survey sites would be in Aparri, Cotabato, and General Santos. In Viet Nam, the eel fishery statistics survey sites would be in Binh Dinh and Phu Yen Provinces, while the eel aquaculture statistics survey sites would be in Ca Mau and Khanh Hoa Provinces. The data collection in both countries would start in January 2022.



Survey sites in the Philippines (left) and Viet Nam (right)

For the eel catch sample survey, IFRDMD conducted the survey from August 2020 to December 2021 in Palabuhan Ratu and Poso, Indonesia. However, lockdown measures were undertaken in Indonesia between July and August 2021 to restrict the spread of COVID-19, making it difficult for the IFRDMD staff to conduct on-site data collection on anguillid eels. Data were therefore gathered by enumerators from the sites and forwarded to IFRDMD. The samples were measured to obtain data on the length-weight of anguillid eels and other morphometric data. Subsequently, when the COVID-19 situation has improved, the IFRDMD staff conducted the eel survey at the Poso River in Central Sulawesi on 13–18 September 2021. The staff gathered information on elvers and yellow eels caught by trap in the Poso River, as well as water quality data from downstream to upstream. The staff also interviewed the owner of the company in the area who is engaged in glass eel rearing and trading.



IFRDMD staff collect data on elvers and yellow eels caught by the trap in the Poso River, Indonesia



Eel trap

On the DNA survey, IFRDMD had successfully analyzed 106 samples from Indonesia (53 samples), Philippines (27 samples), and Viet Nam (26 samples) by using the COI markers. The analysis will be further carried out using Cyt-b and D-loop markers. All of the samples have been identified as *Anguilla bicolor pacifica*. Based on the genetic relationship among samples, the genetic diversity of all samples was divided into two populations that have the same genetic composition; 75 samples were 100 % identical to each other and 31 samples were 100% identical to each other as well. Preliminary results showed that the samples came from the same population; however, further analysis is still needed. IFRDMD is preparing the protocols of eel tissue collection for genetic research and will further analyze the population relationships among samples and genetic differences among populations.

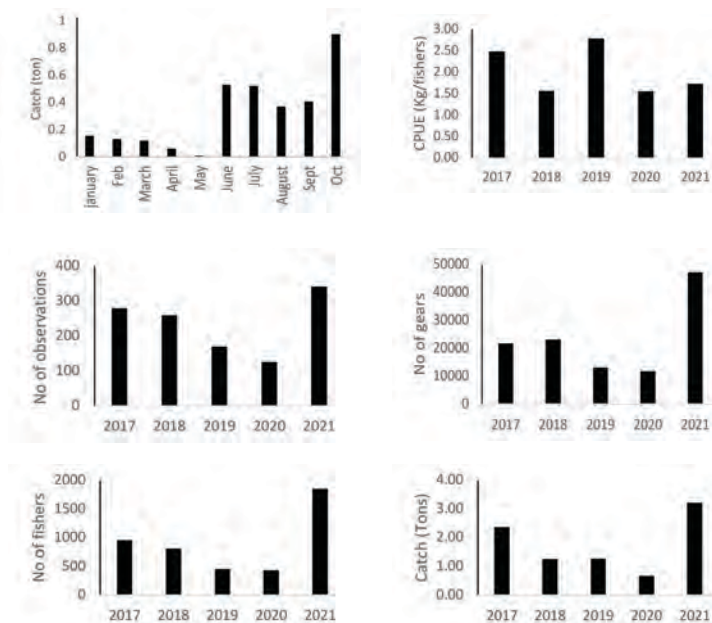
For environmental DNA (eDNA), the Project planned to conduct a feasibility study to investigate the effectiveness of the eDNA technique for tropical anguillid eels in order to explain the pattern of eel distribution in Southeast Asia. The “Interim manual of environmental DNA survey: Water sampling and DNA assay for tropical eels in Southeast Asia” was drafted and the study will start in 2022. Samples will be collected from Luzon (Cagayan River, Bicol Region, and Sariaya, Quezon) in the Philippines.

For the other Project “**Sustainable Utilization of Anguillid Eels in the Southeast Asia Region**” implemented by IFRDMD with support from the JTF from 2020 to 2024, the Project aims to 1) enhance sustainable eel fishery resources through development/



improvement of the standard data collection system in Southeast Asia, and 2) map the genetic population structure of tropical eels in Southeast Asia (*i.e.* Indonesia, Philippines, Viet Nam, and Myanmar) based on mtDNA approach. Since early 2020, the COVID-19 pandemic has impacted the undertaking of activities under this Project; therefore, IFRDMD had adapted the conduct of activities in 2021 by rescheduling or postponing survey in some areas and arranging the Project meetings through the virtual platform. In 2021, there was no glass eel catching in Palabuhan Ratu and Poso, Indonesia, and in Philippines due to the shortfall of demand from eel farms. Also, the Government of Indonesia implemented a quota system to manage glass eel resources, only collector(s) who has a certificate could transfer and receive anguillid eels between different areas in Indonesia. Despite such a situation, IFRDMD successfully collected catch data on elvers from Cilacap, Indonesia from January to October 2021 amounting to 3.2 t.

The CPUE of elvers in Cilacap collected from 2017 to 2021 showed fluctuation trend through the years, with the highest CPUE in 2019 and slowly decreased until 2021. The number of gears used for collecting eels considerably increased from 2017 to 2018 and significantly increased again in 2021. Nevertheless, the number of fishers showed a decreasing trend; and after a drop in number in 2020, it significantly increased in 2021.



Status and trend of anguillid eel fisheries in Cilacap, Indonesia

Since there was no data collection from other areas in Indonesia except in Cilacap, IFRDMD exerted an effort to seek alternative stock assessment method to estimate the current status of anguillid eels. One possible method to assess the eel stock is the acoustic survey by conducting target strength measurement and acoustic tracking survey. Therefore, IFRDMD carried out acoustic survey to determine and analyze the characteristics of the

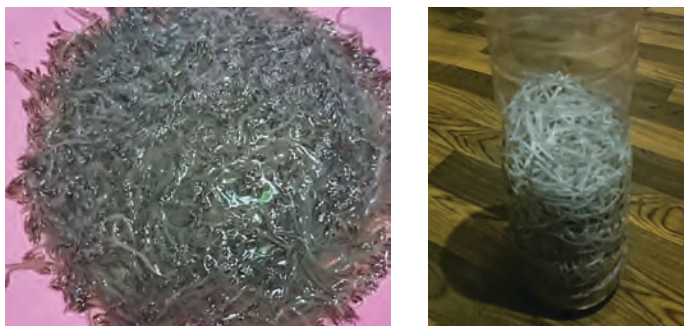
target strength of anguillid eels and calculate eel density by using acoustic methods. The tracking survey was conducted in the Cimandiri River in West Java and in the Serayu River in Central Java in October and November 2021, respectively using the acoustic transducer attached to the side of the vessel. Eels are nocturnal and more active at night. Hence, more eels are detected using acoustic methods during nighttime compared to daytime.



*Cimandiri River in West Java (left) and Serayu River in Central Java (right) in Indonesia*

As for research activities related to the genetic population of anguillid eels, three species of anguillid eels were targeted. Surveys were planned to collect eel tissue samples from Indonesia, Philippines, Viet Nam, and Myanmar; and laboratory work would be subsequently undertaken to analyze the samples. However, the samples from the Philippines, Viet Nam, and Myanmar could not be collected and analyzed due to the COVID-19 situation in these countries; hence, the genetic population analysis could be carried out only for the samples from seven locations in Indonesia, namely: Palu, Poso, Kendari, Bengkulu, Ternate, and Palabuhan ratu.

A total of 332 sequences from Anguillid eels have been identified using MEGA 6.0 software and compared with data from the National Center for Biotechnology Information using the basic local alignment search tool-nucleotide (BLAST-n) method. All samples consisted of several anguillid eel species, namely: *Anguilla bicolor bicolor*, *A. bicolor pacifica*, *A. marmorata*, *A. celebenensis*, *A. Interioris* and *A. nebulosa*. Based on the results of phylogenetic data analysis, a total of 236 samples were identified as *Anguilla marmorata*, Two samples as *A. nebulosa* (Pelabuhan Ratu), one sample as *A. Interioris* (Poso), Ten samples as *A. celebenensis* (Poso and Palu), 26 samples as *A. bicolor bicolor*, and 40 samples as *A. bicolor pacifica* (Kendari, Palu, and Ternate).



*Glass eel samples*

In Indonesia, anguillid eels are not yet widely known as nutritious food fish since the market price was unaffordable for the local people. Nonetheless, eel products could be promoted in processed forms, making the prices more affordable so that people would patronize the products. Nowadays, efforts to introduce eel products to local communities in Indonesia are starting to take shape by producing processed food suited to the Indonesian taste, *e.g.* shredded eel meat, chips, crackers, eel-sourced vitamin mixed with honey for children. Product development strives to change the look of anguillid eels in packaging to ensure that the food fish does not appear like a snake. This way, the Indonesians would be attracted to processed food and increase their preference for consuming the anguillid eels. Recently, a good supply of unagi kabayaki can be found in big markets in Indonesia.

In order that the market price of eels could be reduced, the development of a simple culture method should be considered a priority way forward. However, the availability of glass eels for aquaculture depends on the catch from the wild, which is correlated with the season and location. Moreover, the distance between the fishing area where glass eels were collected and the center of aquaculture is quite far, so mortality during transport is still high. Nevertheless, such problems could be addressed by improving eel transport technology. While hatchery research for eel seeds is still in progress, another concern is the price of feeds for cultured eels which could be expensive. This is because eels require feeds with high protein content (40–50 %), and some components of feeds are still imported. Therefore, the eel price becomes expensive. To deal with this matter, the feed formulation is modified by lowering the protein content and increasing the carbohydrate content. Hence, this feed is affordable for medium-scale aquaculture.

The price of glass eels depends on the demand. For this reason, coordination with collectors should be done prior to the capture of glass eels to make sure that the catch is collected. Glass eel fishers are usually temporary fishers only from evening to midnight. Most of them have other jobs from morning to noon. Nonetheless, they get their fishing gear from collectors.

A significant concern that affects small-scale eel fisheries is, in general, the poverty of fishers. This condition deprives them of having considerable access to utilize the fishery resources. Fishers usually do not have sufficient catching ability because of the lack of capital for acquiring the necessary fishing gear. As a result, their catch is directly sold to middlemen who have lent them money or provided the fishing gear. In the Provinces of Bengkulu and Lampung, the middlemen are also the collectors responsible for sending the eel catch to Java Island. These stakeholders, therefore, have to be aware of the anguillid eel resources in order that the resources could be utilized sustainably.



*Eel culture facility in Bogor (left) and eel trade company in Cilacap (right)*

It should also be considered that gender plays an important role in the anguillid eel supply chain. In Palabuhan Ratu, West Java, women are very much involved in the eel industry, acting as collectors. Moreover, women are also actively involved in capturing the anguillid eels, although it was conducted in the evening to early morning. From the interview conducted by IFRDMD, it was found that the anguillid eel resources in Indonesia are considerable, and the fishers know how to keep the eels sustainable. It is proven by the environment-friendly fishing gears used for capturing the glass eels from the river mouth and elvers in the river.



*Interviewing with women in eel production chain in Palabuhan Ratu*

In Cilacap, Central Java, the team from IFRDMD organized a meeting with the women involved in the anguillid eel fishery. The meeting was attended by 31 women and eight men in addition to the local officer and the fisher leader. Presentations were made on gender, followed by a guide for women to fill out the questionnaire. Besides, the team also met with the fishers to interview on the socioeconomic issues and had the chance to visit the traditional eel farm in the village. From the interview, women in Cilacap are found to be very much involved in the eel industry, acting as collectors. The women have been tapped to manage the financial aspects and bookkeeping as they possess much better capabilities than the men.



*IFRDMD staff presenting the gender issues in fisheries*

## 1.8 Capacity building towards sustainable fisheries

### ***Promotion on Strengthening of SEAFDEC Visibility and Enhancing Human Capacity Building***

In 2021, TD implemented the program “**Promotion on Strengthening of SEAFDEC Visibility and Enhancing Human Capacity Building.**” TD publicized its information through various channels, *i.e.*:

- **Website** – information, activities, and news were promoted through the official website of TD at <http://www.seafdec.or.th>
- **Social Media** – TD has 24 articles on fisheries management, fishing technology, combating IUU fishing, and fishery resources produced and disseminated through the official Facebook page of TD at <https://web.facebook.com/SEAFDECTrainingDepartment>
- **YouTube** – TD has produced and uploaded 13 video clips in the field of fisheries on its official YouTube channel at <https://www.youtube.com/channel/UC-LMmTRM-mLV3FZScO1gUQg>
- **Institutional Repository** – the publications and documents produced by TD were uploaded on the TD institutional repository at <http://repository.seafdec.or.th>

## 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 2021, SEAFDEC/AQD continued to implement the regional project “**Sustainable Aquaculture through Cost-effective Culture Systems and Prompt and Effective Aquatic Animal Health Management**” with support from the Japanese Trust Fund covering the period from 2020 to 2024. The expected outputs of this 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. The activities implemented under this Project in 2021 were as follows:

#### ***Community-based hatchery, nursery, and grow-out of giant freshwater prawn***

Farming of high-value giant freshwater prawn (*Macrobrachium rosenbergii*) holds the good potential to improve income for inland fishing communities. However, widespread adoption of the giant freshwater prawn as an aquaculture species is hampered by the lack of juveniles to supply grow-out farms. AQD, therefore, aims to develop community-based strategies to mass-produce the giant freshwater prawn postlarvae to supply grow-out operators in Laguna Lake and its tributaries in the Philippines.

Social preparation and formulation of local policies and governance strategies were undertaken in 2021. The Pipindan Aquaculture Producers Association (PAPA) was established with the concurrence of the local government. The results from the baseline

surveys previously conducted in 2020 were verified based on the bottom-up approach for community-based projects. It was found that the respondents had decreased incomes by 26 % due to the COVID-10 pandemic. The structural design of the community hatchery to be built in Binangonan, Rizal, Philippines was completed in 2021; however, the planned training of fish farmers was delayed due to the COVID-19 restriction measures. It is expected that the construction of the small-scale hatchery and the training activities would be commenced in 2022.



*Meeting of Pipindan  
Aquaculture Producers  
Association officers*

### ***Promoting alternative feeds for sustainable production of freshwater aquaculture species***

To reduce the cost of feeds, especially for small-scale freshwater farmers, AQD aims to develop alternative feed formulations and feeding strategies. It is expected that the replacement or reduction of fish meal and other expensive conventional ingredients with the alternative protein sources for fish and shrimp diets, such as aquatic weeds, invasive alien species, microbial biomass, and fish by-products, may help in reducing feed costs as it provides affordable options in fish feed formulations.

Two alternative feeds and feeding strategies were tested for Nile tilapia fingerlings reared in tank- and lake-based cages during the wet season. Diets incorporating bacteria-treated okara meal (BOM) and yeast-treated okara meal (YOM) were tested across daily and alternate-day feeding strategies. After 12 weeks of culture, it was found that the diet type affected the growth and feed utilization of tilapia in tank trials but not in lake trials. In tank trials, diets with BOM had significantly higher mean final weight, percent weight gain, specific growth rate (SGR), and final yield. Meanwhile, the feed conversion ratio (FCR) was significantly higher in groups fed diets with YOM. In both trials, daily feeding resulted in higher mean final weight, percent weight gain, SGR, and final yield; however, alternate-day feeding resulted in better FCR. For survival, alternate-day feeding in tanks showed better survival but did not make a difference in lake trials.

In a separate study on aquatic weeds, water hyacinth and water cabbage were used to replace soybean meal in diets for tilapia in a biofloc-based system. After 16 weeks of culture, inclusion levels of the aquatic weeds between 0 % and 11 % yielded no significant difference in terms of mean body weight, weight gain percentage, and SGR. High survival rates of 91 % to 98 % were observed in all cases. Biometric indices likewise did not show significant differences. More feeding trials using other alternative ingredients will be undertaken in 2022.

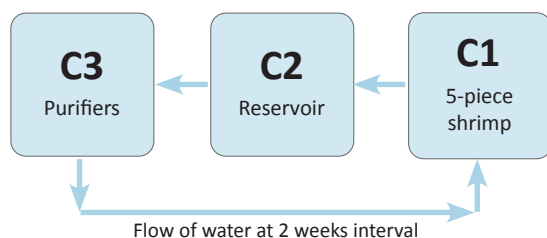


Water hyacinth (left) and water cabbage (right) used as soybean meal replacement in tilapia feeds

### **Ecosystem approach to responsible and sustainable shrimp farming**

To help minimize and mitigate the occurrence of diseases in shrimp farming, two ecosystem approaches for small-scale farmers are being examined. The first is to enhance the purification of rearing water by utilizing aquatic organisms. Previous studies had identified seaweeds (*Gracilaria* sp., *Eucheuma* sp., *Caulerpa* sp., *Kappaphycus* sp.), pickleweed (*Salicornia* sp.), abalone (*Haliotis* sp.), sandfish (*Holothuria* sp.), oyster (*Crassostrea* sp.), and mussels (*Perna* sp., *Mytilus* sp.) as candidates for removing nitrogen from the water. These species were tested for their ability to remove ammonia, total ammonia nitrogen (TAN), and phosphate from the environment.

To test the effectiveness of the aquatic organisms to purify the water, a microcosm experiment was carried out using a recirculating aquaculture system to simulate an artificial or constructed wetland. Four sets of interconnected tanks with three compartments each were used. The first compartment (C1) is used to culture shrimp, while the second compartment (C2) serves as a reservoir that receives water from C1. The third compartment (C3) was used to treat effluent from C1 and C2 and was stocked with either *Holothuria*, *Caulerpa*, or *Gracilaria*. Water flowed from C1 to C2 and C3, and back from C3 to C1 once every two weeks. The experiment continued for two months. Preliminary results indicated that sandfish was the best candidate among the three organisms to treat the water. In the sandfish treatment, the shrimp had higher weight gain, lower mortality, and lowest percentage of green *Vibrio* (where most pathogenic *Vibri*os belong) and *Vibrio parahaemolyticus*, the causative agent of acute hepatopancreatic necrosis disease (AHPND). The microcosm experiment will be replicated in 2022 and upscaled to an earthen pond setting.



Experimental schematic design of the microcosm experiment

### ***Development of aquaculture techniques on new aquatic species***

AQD aims to develop aquaculture techniques for breeding, seed production, and eventually grow-out of three new aquatic species, namely: slipper lobster, kawakawa, and shortfin scad, in the Philippines for sustainable utilization of these species and creation of new local aquaculture industries.

- *Slipper lobster*

The scyllarid lobster (*Thenus orientalis*) is one of the five lobster species commonly traded in the Philippines. It is sought after as a seafood delicacy with a good price in the local market ranging from USD 9 to USD 15 per kilogram. The slipper lobster is caught by trawls or speared by divers, the latter remarking that its wild population has dwindled compared to previous years.

Three batches of adult slipper lobster were transported from Sagay City and Escalante City, Negros Occidental, Philippines to AQD's Tigbauan Main Station between April and November 2021. The slipper lobsters were successfully maintained in flow-through concrete tanks with mild aeration. Periodic samplings were undertaken to monitor growth, molting, and presence of eggs. It was observed that the slipper lobster preferred to feed on squid and small silvery fish, locally called "lobo-lobo" or "dulong," compared to *Acetes* and mussels.

Spawning episodes were observed in September and October 2021 and documented by video in the morning at 5:10 a.m. The phyllosomas that hatched were fanned away using the pleopods of the female slipper lobster. Empty egg capsules can be seen still attached to the ovigerous setae, but eventually shed off about 48 hours after hatching. In 2022, trials on egg hatching, feeding, and rearing management will be done alongside observations on the development of hatched larvae.



Clockwise from left: *Dorsal view of slipper lobster, brown pre-hatching egg mass, and fertilized eggs*

- *Kawakawa*

Kawakawa (*Euthynnus affinis*) is one of the neritic tunas that is economically important in Southeast Asia. This fish is an important target species for commercial and local fisheries as a substitute for the oceanic tunas. The rapid growth of this species means that it is potentially attractive as a novel target for aquaculture.



A total of 277 samples of kawakawa were collected from February 2020 to August 2021. The fish samples were sourced from Antique, Philippines using otoshi-ami, ring net, and hook and line, and from Tigbauan, Iloilo, Philippines using purse seine. A total of 29 females, 40 males, and 208 juveniles (undetermined sex) were collected and analyzed for basic biological information such as size, reproductive biology including fecundity, measurement of oocyte diameter, gonadal maturity, and gut content. Further refinement of procedures of handling live specimens will be undertaken to improve survival and monthly samplings will be continued in 2022.

- *Shortfin scad*

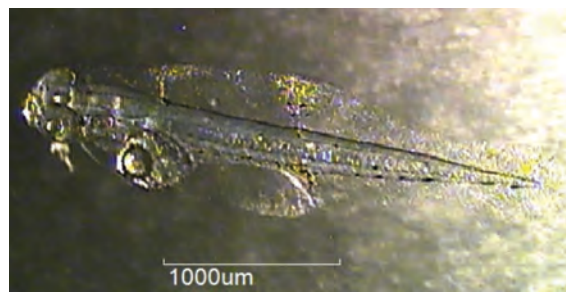
Shortfin scad (*Decapterus macrosoma*) locally known as “galunggong,” is the most important small pelagic fish species in the Philippines. This species is usually caught in large quantities and main source of inexpensive animal protein for people with lower income in the Philippines. However, a decrease in the volume of fishery production of shortfin scad has been observed in the last five years which may be due to overfishing.

In 2021, a total of 216 shortfin scad samples were collected from February to October through a commercial fishing vessel in Antique, Philippines. A total of 87 females, 99 males, and 30 juveniles (undetermined sex) were collected and dissected to determine the body weight and length and reproductive biology including fecundity, oocyte diameter, gonadal maturity, and feeding habits.

Transportation trials of shortfin scad samples were undertaken: the first trial by packing the shortfin scad samples in oxygenated bags and customized transport tank with chiller, while the second trial also incorporated 32 h of pre-transport conditioning in hapa nets. Then, the fish samples were stocked in flow-through broodstock tanks at AQD’s Tigbauan Main Station and fed live mysids, *Acetes*, and anchovy fry on the next day. The trials on egg hatching, feeding management, and rearing management as well as observations on larval development will be carried out in 2022.



*Dissection of kawakawa samples*



*Shortfin scad larvae at day 0*

### ***Development of diagnostic procedures to determine emerging and unknown crustacean and fish diseases***

AQD continued to carry out the monitoring and surveillance of mass mortalities in aquaculture. In January 2021, a follow-up site visit was done in Pontevedra, Capiz, Philippines to reassess the condition of the farm surveyed in 2020 which exhibited mortalities of

mangrove crab, *Scylla serrata*. The farm partially implemented AQD recommendations on improvement of feed quality and observance of good aquaculture practices. Mortalities continued to occur among the crabs, however, an increase in survival rate and average body weight was noted.

Moreover, AQD has undertaken the bacteriological analysis, biochemical identification of bacterial isolates, molecular diagnosis of diseases, and histopathological analysis. Although all the samples from the mangrove crab grow-out farm were PCR-negative to all available PCR detection kits (for WSSV, AHPND, IHHNV, EHP, and HEMATD), a total of 54 bacterial isolates were isolated and identified from apparently weak crabs. These isolates will be subjected to infection experiments in the latter part of the Project since substantial abnormalities were observed in the histopathology of the crab tissues.

In 2021, visits were also made to two *Penaeus vannamei* farms in Zarraga and Ajuy, both in Iloilo, Philippines that encountered diseases despite strict biosecurity and good aquaculture practices. With proactive monitoring, the farm in Zarraga detected white spot syndrome virus (WSSV) at 32 days of culture (DOC). The culture period of shrimp was completed with help of close PCR monitoring and application of probiotics and immunostimulants. On the other hand, the shrimp cultured in the farm in Ajuy was reported to be PCR-positive for EHP (*Enterocytozoon hepatopenaei*) at 76 DOC; thus, a partial harvest was made after the results were obtained.

#### ***Survey of the epidemiology, distribution, occurrence, and prevalence of EHP***

*Enterocytozoon hepatopenaei* (EHP) is a microsporidian parasite that infects the hepatopancreas of shrimps, damaging their ability to gain nutrition from feeds and stunting their growth. Recently, hepatopancreatic microsporidiosis (HPM) caused by EHP has emerged as one of the most important diseases in the shrimp culture industry. The presence of EHP was assessed across six sampling sites in Iloilo, Philippines consisting of three farms and three hatcheries. While microsporidian spores were not detected by wet mount analysis, nested-PCR confirmed EHP in shrimp from Farm 1 in Ajuy, Iloilo and Farm 3 in Dumangas, Iloilo where prevalence in hatchery-reared and grow-out shrimp is 0 % and 10.8 %, respectively. Shrimp positive for EHP were found in the first production cycle run of both EHP-positive farms with varying days of culture. In Farm 1 in Ajuy, samples in the succeeding second and third production cycle runs were negative for EHP despite the positive infection in the first production cycle run. The average prevalence per DOC when EHP was detected was 37.0 % in Ajuy and 13.5 % in Dumangas. In 2022, experiments to understand the transmission of EHP in shrimps will be carried out.



*Infected shrimp samples showing stunted growth, opaque muscle, and hepatopancreas*

### ***In vitro and in hatchery investigation of organisms, chemicals, and methods to prevent or mitigate shrimp diseases***

Black tiger shrimp (*Penaeus monodon*) is one of the important species widely cultured globally. However, the production has decreased due to the occurrence of diseases. Some of the diseases that persistently infect shrimp are caused by the pathogens, such as the monodon baculovirus (MBV), hepatopancreatic virus (HPV), infectious hypodermal and hematopoietic necrosis virus (IHHNV), white spot syndrome virus (WSSV), *Vibrio parahaemolyticus* causing acute hepatopancreatic necrosis disease (APHND), and *Enterocytozoon hepatopenaei* (EHP). The pathogens can be transmitted both vertically and horizontally. Chemicals and methods that can disinfect *P. monodon* fertilized eggs and nauplii against pathogens are currently under examination. In particular, electrolysis, benzalkonium chloride, sodium hypochlorite, sodium chloride, treflan, and laundry detergent are being tested as disinfectants. The search for organisms, disinfectants and chemicals, and methods to prevent the vertical and horizontal transmission of shrimp diseases at the hatchery phase will be continued in 2022.

### ***Integrated management of shrimp diseases***

To implement effective strategies in the management of established and emerging shrimp diseases, trials were conducted using a combination of approaches such as biosecurity and best management practices (BMPs) in a tank microcosm. To determine the efficacy of soil disinfection using chlorine, WSSV-inoculated shrimp were stocked in tanks with soil substrate until they died. The soil was subsequently disinfected with 30 mg/L chlorine for 3–5 days, tilled and dried for five weeks, and compared to a soil substrate that was not disinfected but was similarly tilled and dried. The qPCR analysis showed that soil substrates were positive for WSSV in both the disinfected and the non-disinfected set-ups. To test if the shrimp could be infected via the soil substrate, 57-day old shrimp were stocked and observed for clinical signs or mortalities and tested by qPCR. The shrimp were found to be infected with low levels of WSSV which could be detected only via qPCR but not by conventional PCR. Since the treated shrimp had similar levels of infection as the source postlarvae (PL) stock, the source of the virus could not have come from the soil. A subsequent trial determined if low viral loads in shrimp could further progress into higher levels of WSSV infection. Under good management (no water quality problems), no clinical signs or increase in viral load were observed. However, when the shrimp were exposed to hypoxic stress (severely reduced aeration) due to consecutive power outages, the shrimp experienced high mortality in the tanks followed by the appearance of clinical signs of WSSV infection among the survivors which was confirmed via 1-step and nested conventional PCR. The shrimp with clinical signs had increased viral loads (by qPCR) and later became moribund and died. Experiments on the use of specific pathogen-free (SPF) postlarvae are ongoing.

### **Capacity enhancement on sustainable aquaculture and aquatic animal health management**

To provide stakeholders in Southeast Asia with the knowledge and skills on various aquaculture technologies, the Japanese Trust Fund (JTF) provided fellowship grants to a series of aquaculture training courses. A training course on fish health management was organized to disseminate knowledge, skills, and new approaches in the field. The training on marine fish hatchery was offered twice and covered technologies on broodstock management, spawning, and larval rearing of marine fish species such as milkfish, sea bass, groupers, mangrove red snapper, rabbitfish, and pompano. The community-based freshwater aquaculture training was also offered to promote freshwater aquaculture technologies in rural communities in Southeast Asia.

The date and number of participants in the training courses conducted in 2021 were as follows:

- 1) Distance Learning Course on Principles of Health Management in Aquaculture on 17 January–17 April 2021 with a total of 15 participants (12 were supported by the JTF) from Brunei Darussalam (1), Philippines (11), Singapore (2), and Viet Nam (1)
- 2) Training Course on Marine Fish Hatchery on 14–29 June 2021 with a total of 21 participants (5 were supported by the JTF) from Brunei Darussalam (1), Japan (1), Kiribati (5), Papua New Guinea (2), Peru (1), Philippines (8), Singapore (1), Thailand (1), and USA (1)
- 3) Training Course on Marine Fish Hatchery on 19 July–3 August 2021 with a total of 13 participants (11 supported by the JTF) from Brunei Darussalam (1), Cambodia (1), Malaysia (3), Myanmar (1), and Philippines (7)
- 4) Training Course on Community-based Freshwater Aquaculture for Remote Rural Areas of Southeast Asia on 16–25 November 2021 with a total of 12 participants (11 supported by the JTF) from Brunei Darussalam (1), Malaysia (1), Myanmar (4), and Philippines (6)

Due to the COVID-19 pandemic, these training courses continued to be offered online. Except for the training on aquatic animal health, online training courses used the Canvas platform and consisted of recorded lecture presentations, practical video sessions, discussion boards, assignments, downloadable learning materials, live discussion sessions with resource persons, and live group presentations through Zoom.

## **2.2 Improvement of broodstock and seed production technologies**

Aimed at generating, verifying, and promoting technologies to ensure the sustainable production of quality seed stock for aquaculture and stock enhancement, AQD continued to implement its Departmental Program “**Quality Seed for Sustainable Aquaculture**” which included studies and activities that aim to determine the optimal conditions and cost-effective, science-based methods for producing quality seed stock. Under this Program, enhancement of breeding performance would be promoted by 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 or approaches. The activities undertaken in 2021 were as follows:

### **Broodstock development**

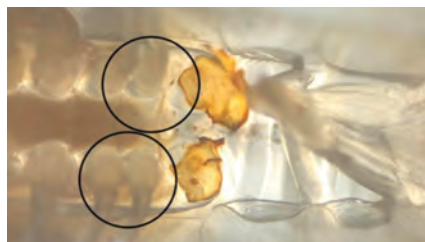
- *Milkfish*

It takes 3.5–5.5 years for milkfish (*Chanos chanos*) to mature. A study was thus carried out to test if advancing the onset of puberty in milkfish was possible through endocrine manipulation. Two neuroendocrine hormones as well as a gonadal steroid are being considered. So far, the gonadotropin-releasing hormone (GnRH) has been tested using different dosages and size groups of milkfish. At least 10 % of milkfish fingerlings (70.0–100.0 g) injected with 100ug/kg of GnRH every two weeks for four months were found to have primary growth stage oocytes on the sixth month of rearing. Larger-sized milkfish juveniles (0.7–1.0 kg) treated with GnRH (5 ug/kg and 30 ug/kg) every two weeks for four months showed that 40 % had primary growth stage oocytes. These results indicated the onset of gonad differentiation and their sensitivity to hormonal manipulation. The gonad samples taken in the sixth month had comparable gonado-somatic index value regardless of treatment.

- *Giant freshwater prawn*

Male giant freshwater prawn (*Macrobrachium rosenbergii*) grow larger and reach marketable size faster than females. Production of all-male (monosex) prawn is thus being considered to improve yields in farms. Towards this, prior research has been done to sex-reversed male prawns into functional females (neo-females) which in turn give birth to all-male prawn. One of the methods to produce neo-females is the ablation (removal) of the androgenic gland of male prawn. The efficacy and cost-effectiveness of the procedure is being verified by AQD.

Partial results showed that prawn ablated at PL<sub>45</sub> produced a significantly higher percentage (23.5 %) of potential neo-females 90 days after ablation, compared to those ablated at PL<sub>63–67</sub> and PL<sub>95</sub>. Postlarvae that showed signs of feminization will be monitored for gonadal development. Other activities to verify the efficacy and cost-effectiveness of the technique will be carried out in 2022.



*Ablated giant freshwater prawn postlarvae, emphasizing surgical areas*

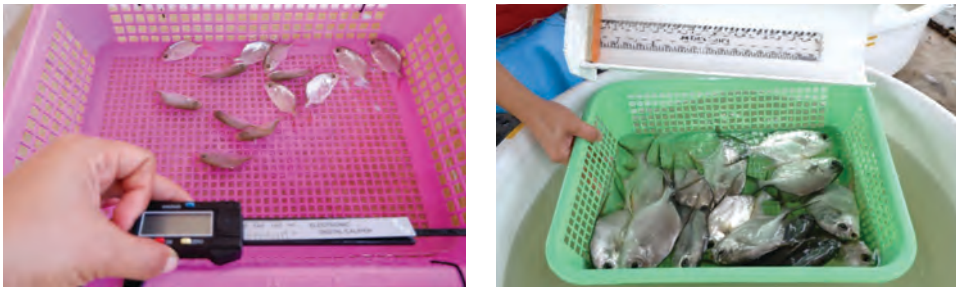
### **Refinement of hatchery and nursery protocols**

- *Pompano*

The optimal conditions for nursery rearing of snubnose pompano (*Trachinotus blochii*) in pond-based net cages are being defined by AQD to improve yields. Also, the best diet and the optimal stocking density for the growth and survival of pompano are being investigated.

Hatchery-reared pompano were stocked in nursery cages set in ponds at a density of 150/m<sup>3</sup>. After 135 DOC, the treatment where the pompano fed with taurine diet gave the highest specific growth rate (SGR) (4.8 %/day). On the other hand, the feed conversion ratio (FCR) was significantly lower in the treatment fed with commercial diet (1.9).

In the grow-out experiment, pompano from the nursery experiment (40–50 g) were stocked in cages in ponds at different densities (3/m<sup>3</sup>, 5/m<sup>3</sup>, 10/m<sup>3</sup>). The experiment was terminated at 79 DOC because of high mortalities. The survival rate, SGR, and FCR did not differ significantly, but biomass was significantly higher at the 10/m<sup>3</sup> stocking density. Another run will be carried out in 2022 using lower stocking densities between 0.3/m<sup>3</sup> and 1/m<sup>3</sup>.



Hatchery-bred pompano juveniles with around 2.5 cm body size (left), and 40–50 g weight after 135 days of culture (right)

- *Shrimps*

The use of biofloc technology in shrimp culture presents several advantages such as better biosecurity due to its zero-water exchange approach, improved feed efficiency, and enhanced growth and health of shrimps. AQD aims to evaluate the development of microbial biofloc using two different carbon sources to improve production and evaluate its effect on the disease resistance of shrimps.

In 2021, the microbial floc produced using milkfish was found to be composed mostly of chlorophytes, protozoans, and nematodes. In growing white shrimp (*Penaeus indicus*) and black tiger shrimp (*Penaeus monodon*), the growth parameters were mostly the same, except for survival which was significantly higher in biofloc tanks than in non-biofloc tanks, regardless of the carbon source (wheat flour and molasses) used. As for the water parameters, the total ammonia nitrogen was significantly lower in tanks that used biofloc. In a challenge experiment, both *P. indicus* and *P. monodon* were infected with *Vibrio parahaemolyticus*, causative agent of the acute hepatopancreatic necrosis disease (AHPND) in shrimps. For both species, shrimp grown and infected within a biofloc system fared better than those grown and infected in non-biofloc system.

- *Mangrove crab*

Mangrove crab (*Scylla serrata*) is the most preferred species for farming in the Philippines due to its fast growth, large size, less aggressive behavior, and tolerance to a wide range of salinities. For grow-out, farmers prefer to stock crabs at the instar stage. However, to

shorten the hatchery production phase, an approach to nurse crabs in pond-net cages beginning at the earlier megalopa stage is being verified. Preliminary results showed the survival rate of up to 87 % after four weeks for crab instars grown in pond-net cages at a stocking density of 50/m<sup>3</sup>. This survival rate is similar to the 83 % survival rate at the 100/m<sup>3</sup> stocking density and higher than the survival rates at 200/m<sup>3</sup> and 300/m<sup>3</sup> at 79 % and 59 %, respectively. Data from a three-week rearing period gave a similar trend. More runs will be done in 2022 with closer monitoring of diseases caused by bacteria and viruses.

- *Oyster*

The study on the larvae of slipper oyster (*Crassostrea iredalei*) was done to determine the optimal ration of algae as feed to maximize growth and survival. Feeding rations tested for the different larval stages were set at low (15,000 cells/ml), medium (20,000 cells/ml), and high (25,000 cells/ml) with the rations increased as the oyster larvae grew. So far, results showed that the number and survival rate of the larvae were higher in the treatments fed with mid and high feeding rations but these decreased through time. The study will continue in 2022.

- *Seaweed*

Seaweed is a very important commodity primarily utilized as food and as a source of carrageenan. A laboratory technique used to mass produce seaweed seedlings is micropropagation which usually takes 90 days prior to stocking in sea cages. The study on *Kappaphycus alvarezii* was conducted to shorten the laboratory period from the usual 90 days of micropropagation in the laboratory. A tank acclimation step was also tested to reduce mortalities due to environmental shock when directly stocking in cages. After the first run, results showed that reducing the laboratory step to 30 days and incorporating tank acclimation resulted in better survival and growth rates at the sea cage nursery stage. Survival and growth rates were better compared to seaweed grown for 60 days, 75 days, and 90 days. At the grow-out stage, seaweed from the 30-day laboratory step also gave better biomass and growth rate. The second run will be completed in 2022.

A separate study is being undertaken to improve the survival rate of seaweed propagules/plantlets, reduce the cost of producing propagules in sea-based nursery cages, and eventually distribute quality propagules to farmers. Toward this, an experiment is currently being carried out on the use of commercial disinfectants for seaweeds affected by the epiphytic filamentous algae and ice-ice disease. Another ongoing experiment is comparing the growth performance of AQD's tissue-cultured plantlets with farm-sourced seaweeds.

- *Sandfish*

Sandfish *Holothuria scabra* is an important tropical sea cucumber species but its wild population has been rapidly declining since the late 1980s because of overfishing to meet its high global demand. Sandfish hatcheries have been established worldwide to enable the farming of the species, but most suffered from a very low survival rate of less than 1 % as an annual average. Protocol refinements at AQD supported the survival rate of 6–7 % during good seasons, but problems with environmental conditions and nutrition still need solutions. In 2021, hatchery facilities like the tank aeration and automated heating systems,

as well as a dedicated *Chaetoceros calcitrans* culture station at the sandfish hatchery were improved. However, broodstock collection was very limited in 2020–2021 due to COVID-19 travel restrictions which resulted in overall low annual seed production volume. In another study on the use of AQD's concentrated microalgae as feed for larval sandfish, results showed that live *C. calcitrans* still fared significantly better than flocculated and centrifuged *C. calcitrans*, but the latter indicated some high prospects as a good alternative.

### ***Production of alternative natural food organisms for hatchery and nursery rearing of commercially important aquatic species***

- *Mudworm*

A study is being carried out to demonstrate the feasibility and profitability of indoor tank-based polychaete (*Marphysa iloiloensis*) culture. Refinements in the culture protocol for polychaete production have been made by defining the appropriate feeding rate and sediment depth required in producing sufficient polychaete biomass. The best polychaete survival rate and biomass were noted when the 50 g/m<sup>2</sup> feeding rate and 3–5 cm sediment depths were used in polychaete culture from early juvenile to adult. However, both survival rate and biomass were significantly higher when the 100 g/m<sup>2</sup> feeding rate was used in culturing adult *M. iloiloensis*.

- *Larval food*

A modified continuous culture system is being developed for the mass production of *Nanochlorum* sp. and *Brachionus rotundiformis*. In 2021, the presence of ciliates in the *Nanochlorum* culture system was encountered addressed by way of a bleach assay experiment where the algal culture was subjected to three different treatments (1 µl bleach, 10 µl bleach, and 100 µl bleach) to rid the system of ciliates. Based on the run, a 1 µl bleach treatment is effective in keeping the cell density of *Nanochlorum* at a relatively high and steady level compared to the other treatments. Other activities will continue through 2022.

- *Rotifer*

The use of the rotifer *Proales similis* as the first food for small-mouthed marine fish larvae is being explored. To this end, mass production schemes for *P. similis* are being developed. Sufficient *P. similis* were obtained from an initial 80 L (containing  $4.2 \times 10^6$  Proales ind/ml) to 180 L ( $1.37 \times 10^8$  Proales ind/ml) when a production protocol using centrifuged algal paste was used. Infestation of the *P. similis* stocks by ciliates was observed, but the ciliate-free culture was done through isolation of individual *P. similis* followed by gradual scale-up. Ciliate contaminants were not observed up to 250 ml. Ciliate presence was inevitable at higher volumes but greatly reduced.

- *Copepod*

A study is being done to develop a large-scale culture protocol for harpacticoid copepods (*Tigriopus* sp.) which are potential food for marine fish larvae. Results of the production trials showed that the highest copepod population growth was recorded at a peak of 200,000 individuals when 10 ml biofloc concentration was used.



### **Promotion of technically and economically viable breeding and seed production schemes**

- *Abalone*

The hatchery production of donkey's ear abalone (*Haliotis asinina*) juveniles is being demonstrated while verifying the efficacy of different diets on the reproductive performance of broodstock, and the growth and survival of abalone juveniles.

From January to September 2021, 128,942 abalone juveniles (3–5 mm) were produced in the abalone hatchery. The average survival rate from veliger stage larvae to the early juvenile stage was 1.99 %. Abalone broodstock fed with formulated diet was observed to spawn twice yielding 640,000 veliger larvae. Seaweed-fed broodstock spawned four times and produced 1,610,000 veliger larvae. When different types of artificial diets (refined flakes, unrefined flakes, refined pellets, unrefined pellets) and natural food sources (seaweeds, *Spirulina* + diatoms) were given to abalone juveniles, those fed with seaweeds had the highest average body weight (ABW) followed by the juveniles fed with refined pellets. The least ABW was noted in the juveniles fed *Spirulina*+ diatoms. Further trials are underway.

- *Mud crab*

Mass production of crab instars is continuously being carried out at AQD to support in-house research projects and to provide the needs of nursery and grow-out pond operators. A total of 687,500 mangrove crab instars were produced in the hatchery in 2021 of which 451,840 were disposed to research projects and buyers from the Philippines. Meanwhile, 23,400 megalopa were used for research projects. Out of a total of 265 broodstock collected from various sources in the Philippines, 32 spawned and 14 hatched. Some broodstock collected did not spawn, others were positive for WSSV and were discarded, and 242 died prior to spawning despite disinfection procedures.



*Harvest of  
mangrove crab  
instar*

- *Giant freshwater prawn*

AQD aims to promote the culture of the giant freshwater prawn in Western Visayas, Philippines by demonstrating the efficient production of seed, profitability of the venture, and bolstering the local supply of postlarvae. In 2021, the multispecies freshwater hatchery at the Tigbauan Main Station continued to operate, producing 78,557 postlarvae that were used for in-house studies and the rest distributed to buyers from Capiz, Iloilo, and

Negros Occidental, Philippines. Production will be scaled up in 2022 to meet the numerous inquiries and requests from local farmers.

- *Seaweed*

A production study is being done to increase the production of seaweed propagules through micropropagation in a land-based nursery and determine the economics of micropropagule production in the land-based nursery. *Kappaphycus alvarezii* were sourced from Caluya and Pandan, Antique, Philippines. As of August 2021, the nursery produced 38,659 propagules with an average survival rate of 77.3 %. However, the sourcing of explants is being hindered by the COVID-19 restriction measures.

### 2.3 Ensuring food safety through sustainable aquaculture methods

AQD continued to implement its Departmental Program “**Healthy and Wholesome Aquaculture**” comprising two components, namely: 1) Fish health and 2) Nutrition and feed. The fish health component concentrates on disease diagnosis, control, monitoring, and surveillance of aquatic animals as well as environmental integrity, certification, and food safety. The nutrition and feed component focuses on studies to address some problems and need areas to sustain the production of aquaculture products in the region.

#### ***Culture of pompano in cages with different feeding rates***

Snubnose pompano (*Trachinotus blochii*) is well suited to cage culture because of its fast growth rate and excellent meat quality. To improve profitability, a study was undertaken in 2021 to optimize the feeding rate. Four feeding rates were tested for 103 days of grow-out culture in cages at the Igang Marine Station of AQD in Guimaras, Philippines. High feeding rates yielded the best growth. FCR was also much higher at high feeding rates and significantly lower with lower feeding rates.

**Table 2.** Growth parameters of pompano grown at different feeding rates

| Treatment      | Feeding rate | Survival rate (%) | Initial ABW (g) | Final ABW (g) | % Weight gain | FCR  |
|----------------|--------------|-------------------|-----------------|---------------|---------------|------|
| High Feed Rate | 5–6%         | 97.04             | 61.0            | 350.37        | 474.38        | 3.97 |
|                | 4–5%         | 98.32             | 63.0            | 325.47        | 416.62        | 3.44 |
| Low Feed Rate  | 3–4%         | 97.36             | 70.5            | 287.59        | 307.93        | 2.42 |
|                | 2–3%         | 96.76             | 71.0            | 191.19        | 169.29        | 2.06 |



*Harvest of pompano in cages at AQD Igang Marine Station of in Guimaras, Philippines*

### ***Cost-efficient alternative ingredient blend for pompano***

To come up with a cost-efficient formulation for pompano grow-out in sea cages, fish meal protein in formulated feeds was replaced with various blends of alternative protein sources. Soybean meal, corn protein concentrate, protein-enhanced copra meal, poultry by-product meal, and hemoglobin meal were blended into four different formulations and compared to a completely fish meal-based diet. After 90 days of pompano culture in cages, it was found that the diets with alternative protein ingredients performed poorly compared to the formulated diet that was completely based on fish meal. In another experiment, corn protein concentrate was used to replace fish meal and enzymes were added. This experiment will continue in 2022.

### ***Fungi-fermented feed ingredients as the alternative protein source***

Grains, seed meals, and leaf meals are potential protein sources for aquafeeds to substitute for the expensive and unsustainable fish meal. However, these are underutilized because of their lower protein content compared to fish meal, high fiber content, and the presence of anti-nutritional factors (ANFs). Solid-state fermentation (SSF) using filamentous fungi is a cost-effective way to increase protein content, reduce fiber, and remove ANFs of plant-derived feed ingredients.

A total of 12 feed ingredients were processed and fermented using spores of the fungi *Aspergillus oryzae* for five days. Results showed that fermentation with *A. oryzae* can significantly improve protein levels of the feed ingredients tested, except for *Ulva* algal meal and *Azolla* meal. Fine-tuning of the fermentation process is ongoing and feeding experiments will be conducted in 2022.

**Table 3.** Changes in protein levels of feed ingredients after static fermentation with *A. oryzae*

| Feed ingredient                                   | Protein level (% dry matter) |           | Rate of increase (%) |
|---|------------------------------|-----------|----------------------|
|   | Unfermented                  | Fermented |                      |
| <i>Gliricidia</i> (madre de cacao) leaf meal      | 23.57                        | 26.86     | 13.96                |
| <i>Tricanthera</i> (madre de agua) leaf meal      | 17.02                        | 18.93     | 11.24                |
| <i>Leucaena</i> (ipil ipil) leaf meal             | 36.04                        | 39.24     | 8.88                 |
| Cassava leaf meal                                 | 31.03                        | 35.77     | 15.27                |
| <i>Ipomoea aquatica</i> (water spinach) leaf meal | 31.65                        | 35.03     | 10.69                |
| Soybean meal                                      | 53.19                        | 57.20     | 7.54                 |
| Corn meal   | 7.53                         | 8.30      | 10.27                |
| Rice bran   | 13.47                        | 15.00     | 11.36                |
| Wheat flour                                       | 12.08                        | 13.39     | 10.85                |
| Corn starch                                       | 0.27                         | 0.33      | 25.00                |
| <i>Ulva</i> algal meal                            | 22.36                        | 20.57     | -7.98                |
| <i>Azolla</i> meal                                | 23.12                        | 23.54     | 1.85                 |



From left to right: *Gliricidia* (madre de cacao) leaves, *Tricanthera* (madre de agua) leaves, *Ulva* sp. and *Azolla* sp. used as alternative protein sources

### **Production techniques for culture of silver therapon**

Silver therapon (*Leiopotherapon plumbeus*) is an endemic freshwater fish in the Philippines and is regarded as one of the most valuable edible native freshwater species. AQD has been developing domestication techniques for the fish to conserve its natural population which has been dwindling due to intense fishing pressure. Growth and feed utilization experiments were carried out in 2021 using two formulated diets and two feeding rates in nursery rearing. Diets did not have an effect on growth, survival, and FCR in the tank- and lake-based cages. Meanwhile, a higher feeding rate resulted in elevated FCR. In another experiment to define the dietary protein requirement of fingerlings, it was found that the optimum protein level in feeds was 35 %. Experiments will continue in 2022.



Lake-based nursery cages for silver therapon

### ***Polyculture of tilapia and giant freshwater prawn in biofloc***

Biofloc technology is an approach that promotes sustainable food production by minimizing feed costs and waste products. The study is being conducted to evaluate the efficiency and profitability of Nile tilapia–giant freshwater prawn polyculture using a biofloc system at different feeding rates. Preliminary results in pond trials showed a better weight gain of tilapia in polyculture with the giant freshwater prawn compared with the traditional culture. However, the growth of the giant freshwater prawn was better in the traditional culture. More experimental runs will be carried out in 2022.

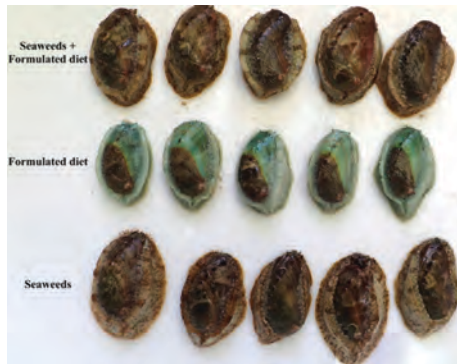


Giant freshwater prawn grown in ponds with biofloc

### ***Natural and formulated feeds for abalone***

The grow-out culture of abalone is still dependent on the seaweed *Gracilariopsis heteroclada*, its natural diet. Unfortunately, the supply of seaweed is limited. Although AQD has long developed formulated feeds for the donkey's ear abalone (*Haliotis asinina*), recently the focus is being given to lowering the cost to improve the profitability of abalone farming.

Nine different diets, including seven new formulations, underwent preliminary testing for stability, composition, cost, and growth performance of abalone. An unrefined flake diet was chosen, considering all criteria. Six months after stocking, the best growth was achieved in abalone fed a mix of seaweed and formulated diet, followed by those fed with seaweeds only, and lastly, those fed the formulated diet only. Survival was highest in abalone fed with seaweeds only, followed by those fed a mixed diet, and lastly by those fed a formulated diet only.



*Abalone fed different diets at six months after stocking*

### ***Refined formulated feed for mangrove crab***

Conventional feeds used in mangrove crab culture are fish bycatch and slaughter waste products. These kinds of feeds, however, easily spoil water quality and may carry disease agents that affect crabs. They are also prone to supply fluctuations and spoilage. To resolve this, a refined water-stable formulated feed for mangrove crab was developed and tested in juveniles in various combinations with fish bycatch. After 90 DOC, crabs fed with the refined formulated feed alone performed best. Growth performance declined with increasing proportions (25 % and 50 %) of fish bycatch given, but these were still better than those fed only a commercial feed. Crabs fed with fish bycatch alone performed very poorly and did not survive after 90 DOC.



From left to right: *Refined formulated feed, commercial feed, and fish bycatch*

### ***Improvement of white shrimp reproductive performance***

Optimal nutrition has shown to improve the reproductive performance of shrimp. However, effective diets are mostly fresh squid, bivalves, and polychaetes. To overcome the limitations of fresh diets, the study was carried out to develop formulated broodstock maturation feed for the white shrimp (*Penaeus indicus*) that is comparable with fresh diets. One strategy was to include polychaete extracts in the formulation to speed up gonad maturation and improve the shrimp's sperm quality. Results showed that the inclusion of at least 0.25 % polychaete polar lipid fraction (PLF) can increase broodstock gonad maturation by 20 % compared to those fed with basal and control fresh diet. At the same PLF inclusion, a 4.4-fold increase in the relative expression of vitellogenin mRNA was also determined. Meanwhile, the polychaete total soluble and neutral lipid fractions were the more effective dietary supplements to improve sperm counts of male *P. indicus* broodstock.



*Successful mating confirmed by the presence of sperm in the thylecum of female P. indicus broodstock*

### **Detection, quantification, and viability of Tilapia Lake Virus**

In 2009, a novel virus named Tilapia lake virus (TiLV) caused mass mortalities of farmed tilapias in Israel and Ecuador and has since then been reported in many countries. To support efforts to monitor the virus, a molecular detection technique was developed to specifically detect TiLV. A duplex semi-nested protocol was thus developed and tested in the field. The protocol may be used in fish samples but may not work for environmental samples such as water, soil, and sediments. The Project determined that TiLV can be found in various areas in the Philippines in different types of culture such as in the wild, ponds, and floating cages. TiLV can infect all developmental stages of tilapia from fry to adult which may exhibit disease signs or may be asymptomatic.

### **Detection, control, and treatment of catfish pathogens**

Sporadic mortalities in pond-cultured African catfish (*Clarias macrocephalus*) have been observed by farmers in Iloilo, Philippines. The study on the monitoring and surveillance of the disease-causing agent was set up. Isolates from catfish hatcheries and nurseries were examined to identify the presence of bacteria. A total of 19 species of bacteria were observed in the hatchery and 26 species in the nursery. Fifteen have already been sequenced. The study also found that catfish eggs in the hatchery did not hatch due to high water hardness. Monitoring will continue in 2022.

### **Vaccination of cage-cultured marine fish**

A nervous necrosis virus (NNV) has been causing the viral nervous necrosis (VNN) disease which leads to high mortalities in farmed marine fish species. AQD has developed a vaccine against VNN but it still needs verification in the field. A total of 81 assorted marine fish, including pompano broodstock, were booster vaccinated against VNN disease in 2021, out of the 93 of those that received primary vaccination in 2020. In 2021, 256 marine fishes received primary vaccination against VNN. Milt, eggs, and spawned eggs from vaccinated and unvaccinated pompano broodstock were negative for the NNV according to RT-PCR results. NNV detection in milts, eggs, and spawned eggs collected from both vaccinated and unvaccinated pompano broodfish is ongoing. No incidence of abnormality/mortality was observed among the offspring currently being reared at the hatchery in AQD's Tigbauan Main Station. Vaccination of high-value fish broodstock in cages and land-based tanks will continue in 2022.

### ***Control of pompano sea lice infestation***

Currently, sea lice (Caligidae) infestation is the most significant disease problem affecting pompano being reared in cages and tanks. The efficacy of emamectin benzoate as an in-feed treatment for pompano was demonstrated in 2020. In 2021, the efficacy of hydrogen peroxide and freshwater bath to control sea lice in pompano was demonstrated. In a first run, sea lice prevalence decreased on the third day after treating pompano with freshwater (80 %), 1,500 ppm hydrogen peroxide (65 %), and 2,000 ppm hydrogen peroxide (45 %). Prevalence in untreated groups remained at 100 %. Confirmatory runs will be done in 2022.

### ***Seaweed disease and pest detection***

The seaweed industry is beset by various diseases and pests resulting in the decline of seaweed productions. The study established key diagnostic tools (detection protocols and molecular diagnostic tools) for yield-limiting seaweed diseases and pests (*e.g.* epiphytes and endophytes). The tools include histology, electron microscopy, and polymerase chain reaction. The epiphytic filamentous algae collected in Iloilo was identified as *Melanothamnus thailandica* which is possibly a new epiphyte affecting farmed seaweeds in the Philippines. Together with other researchers involved in the Project, the seaweed brochure was produced entitled “Farm Management and Biosecurity Measures of Eucheumatoids: cultivars, pest and diseases, risks and risk managements.” The brochure is available in English and three Philippine dialects (Tagalog, Bisaya/Cebuano, and Tausug). The two posters entitled “Commercially Farmed Eucheumatoids” and “Major Problems in Eucheumatoid Farms” are due for printing and distribution.

## **2.4 Development of responsible and sustainable aquaculture technologies**

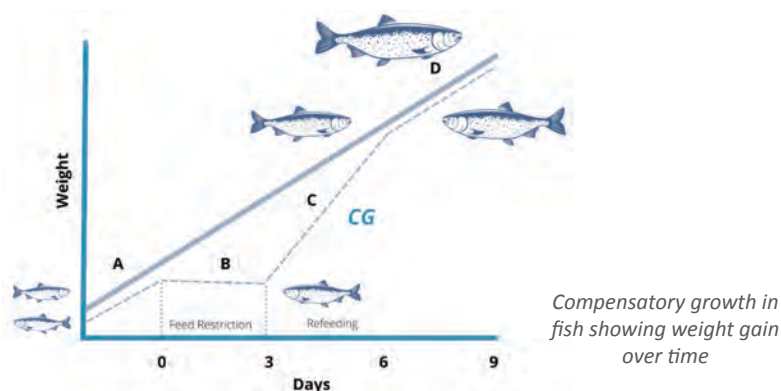
Through its Departmental program on “**Maintaining Environmental Integrity through Responsible Aquaculture**,” AQD continued to develop environment-based aquaculture technology by integrating environmental factors in its research activities and to maintain environmental integrity by promoting responsible aquaculture practices.

### ***Strategic feeding of milkfish***

With feeds accounting for 70 % of operational expenses in milkfish cage culture, strategies to reduce feed cost will have a significant impact. One way is to take advantage of compensatory growth (CG) wherein fish grow rapidly after a period of food restriction. However, defining the optimal period of food restriction is important as too long or too short will result in irreversible stunting of growth or failure to stimulate compensatory growth.

Based on preliminary work since 2019, feeding schemes were designed and tested in the grow-out cage culture of milkfish in 2021. Results confirmed that feeds can be strategically given to utilize the natural CG mechanism in milkfish during its grow-out in marine cages. Repeated cycles of three days starvation and 12 days of refeeding can reduce feed input by up to 20 % while still achieving a harvest volume comparable to continuous feeding.





### **Community-based sea cucumber production**

Sea cucumber (*Holothuria scabra*) mariculture offers livelihood opportunities for coastal communities throughout Southeast Asia. Hatchery and field culture methods have been previously developed with support from the Australian Centre for International Agricultural Research (ACIAR). The improvement of technical skills and the reliability and efficiency of these methods to support community-based sandfish culture in Philippines and Viet Nam is currently being done.

In 2021, imported and locally available algal concentrate products were tested in the hatchery as food for sandfish. It was found that a diet of live *Chaetoceros calcitrans* was still better, but two imported brands of concentrated algae (*Isochrysis* and a diatom mix) may be acceptable alternatives. Further trials will be carried out in 2022, including the evaluation of AQD's *C. calcitrans* concentrate being the best-performing locally available product during initial testing.

In another experiment, the likelihood of predators preying on the sandfish was evaluated in a field experiment that compared two pen designs. In general, the growth of sandfish was better in pens with a higher net enclosure that excluded predators compared to pens with a low net wall that allowed predators in. After 15 months, the higher pens also had a much better sandfish survival rate of 80% than the low pens where no sandfish survived. In areas where the potential for predation is high, rearing sandfish in pens with high net walls can improve growth and survival rates. Analyses of sediment characteristics and biophysical parameters will continue in 2022, as well as testing other potential predator-mitigation strategies.

### **Fish-prawn co-culture in tanks and lake cages**

Despite the potential to boost farm yields, the co-culture of genetically enhanced seed stock, such as tilapia, along with other low-input species, such as prawns, have not been fully utilized in local small-scale aquaculture. The study was carried out to jointly produce genetically-improved Nile tilapia or red tilapia hybrids, together with giant freshwater prawns in tanks and lake-based cages.

Results from the tanks experiments showed that I-ExCEL Nile tilapias, with an average weight gain (AWG) of 181.6–239.4 g had better growth performance to marketable size compared to red tilapias with 110–143.7 g AWG, using either monoculture or in co-culture systems with prawns, especially during the wet season. In terms of survival rate, red tilapias (76.7–95.0 %) had a slight advantage, though not significant, compared to the I-ExCEL Nile tilapias (75–90 %), especially when co-cultured with prawns. Based on overall production traits, experimental runs conducted during the dry season were better than runs during the wet season. For the tilapia-prawn co-culture part of the study, good results were obtained when using low-stocking densities of 10 /m<sup>2</sup> and 7.5 /m<sup>2</sup> for tilapias and prawns, respectively, under favorable water quality conditions.

In a separate experiment, three feeding schemes were tested in lake cages: only tilapia fed, only prawn fed, and both tilapia and prawn fed. Results showed that in the treatment where only tilapia were fed, tilapias grew at rates that are comparable with those where both tilapia and prawn were fed. Interestingly, even when unfed, the prawns grew to a marketable size, gaining an average of 32.3 g in five months.

Considering the performance of all test species, the study concluded that red tilapias stocked at 10 /m<sup>2</sup> in net cages set inside tanks with prawns (7.5/m<sup>2</sup>) can grow and survive well with prawns even when only the red tilapias are fed since the prawns grew and survived at higher rates. Although the prawn growth rate was not quite optimal, the co-culture of prawn using the recommended set-up is still technically viable for fish farmers to adopt.



*Tilapia and prawn co-culture setup in tanks (left) and lake cages (right)*

### ***Integrated multi-trophic aquaculture***

Growing aquatic organisms from different trophic levels together in one system harnesses the potential for one species' wastes, such as uneaten feed, feces, and other metabolic products, to serve as input for the other species in the same system. This approach potentially minimizes its environmental impact while maximizing the use of feed inputs. In collaboration with the Japan International Research Center for Agricultural Sciences (JIRCAS), a combination of fed fish (milkfish), a deposit feeder (sea cucumber), and plants (seaweed) were tested in an integrated multi-trophic aquaculture (IMTA) pen set-up.

The IMTA set-up design has evolved since 2015 to address various problems encountered respective of the species. The traditional 2D IMTA, where all commodities occupy the same pen, was found to be problematic, especially at low tide where the swimming space for fish

became limited because of the seaweeds, while feed waste was too much for the sandfish. The 3D IMTA, where seaweeds and sandfish were cultured adjacent to the primary fish pen showed a promise. Seaweeds proliferated but showed significant seasonality, and mortality was high due to predation by herbivores. On the other hand, sea cucumbers (sandfish) have consistently shown good growth but were stunted after 4–5 months. In a 4D IMTA, stunted sandfish were re-stocked inside the primary fish pen to feed on remaining organic materials after harvesting of the milkfish. Experimental demonstration of IMTA from 2011 to 2018 showed that milkfish in this IMTA set-up produced marketable sizes at harvest. However, because of the small-scale and the open pen system, there was no clear significant bioremediation effect from sandfish and seaweed. In the recent culture trials in 2020 and 2021, the IMTA pen showed to be better as a nursery system for sandfish, than as a grow-out system. Consolidated results of the study will be published in 2022 in the form of workshop proceedings.

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

In 2021, AQD continued to carry out activities under its Departmental Program “**Meeting Socio-economic Challenges in Aquaculture**” with the aims of implementing socioeconomic research and development studies to promote the inclusive engagement of fisherfolk communities and small-holder fish farmers in aquaculture and resource enhancement. These studies cut across the role of aquaculture in seed production for grow-out culture and stock enhancement to improve food and income security among small-scale fishers in coastal areas and freshwater environments.

### ***Community-based sea cucumber ranching***

Sea cucumbers are consumed and traded in Asian markets as a high-value delicacy and as part of traditional medicine. The growing demand for its products led to the depletion of the wild stocks. Mariculture may help rebuild sea cucumber stocks via deliberate culture-based sea ranching or as a by-product of restocking and stock enhancement. It may also be an economically and ecologically sustainable supplemental livelihood for coastal fishing communities.

Under the program, AQD carried out the project with support from ACIAR to develop a community-based sea cucumber (*Holothuria scabra*) production system, which includes the operation of a small-scale hatchery, nurseries, and sea ranch farms managed by fishing communities and families to provide them with additional livelihood. Understanding social and economic dynamics is as important as species biology and ecology, thus, the study is ongoing to cover the socioeconomic component of the program.

In 2021, all fieldwork activities were halted due to COVID-19 travel restrictions. The local Molocaboc Sea Ranchers Association (MOSRA) participated in an online-assisted survey to assess the situations in the community amidst the pandemic. Trained MOSRA members continuously monitored and maintained the sandfish sea ranch site with minimal remote supervision from researchers. They facilitated regular monthly coastal clean-ups, met regularly with local village officials, and conducted the election of 2021 MOSRA officers.

Fishing was the primary livelihood for MOSRA members. Household size of four, on average, earned PHP 3,140 (around USD 60) monthly during July, August, and October and PHP 4,677 (around USD 90) from March to May (peak months) from all livelihood sources, which is below the poverty threshold estimated at PHP 10,481 (around USD 200) (PSA, 2019), on average, for a family of five. Many of MOSRA members had their income supplemented by amelioration allowances from government agencies like the Department of Social and Welfare Development and remittances from relatives.

Five years ago, MOSRA members perceived that sea cucumbers stocks have declined, with most (60 %) of members saying their catch volume decreased due to an increase in the number of gleaners fueled by the strong market demand for sandfish. More than three-fourths (79 %) of MOSRA members are gleaning for sea cucumbers that became a substantial part of their livelihood, particularly during typhoon season. The COVID-19 pandemic intensified the sustenance gleaning of undersized sandfish, particularly by women and children. Therefore, the study engaged in information dissemination campaigns using infographics and posters about the ecological and economic downside of harvesting small sizes of sandfish. Such campaigns will be supplemented with actual lectures and videos for local gleaners, industry players, government officials, and children when travel restrictions are lifted.



*Newly-built floating hut serving as guarding and sampling post*



*MOSRA members collect big sandfish from the sea ranch for monitoring*



*Women of MOSRA monitoring the growth of sandfish collected from the sea ranch*



*Information drive activity*

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

To ensure the sustainability of aquaculture amid the threats of climate change, AQD compiles scientific data and information on the effects of increasing temperature and acidity, as well as other perturbations in the culture environment that affect the growth, survival, and performance of different cultured species. Aside from the inclusion of climate change topics in aquaculture training courses and the dissemination of relevant developments in climate research, several activities under AQD's Departmental Programs investigate the impact of environmental variations on aquaculture organisms.

Research has previously described how environmental parameters affected the growth, reproduction, and survival of farmed commodities in different stages. Rabbitfish (*Siganus guttatus*) and mangrove crab (*Scylla serrata*) broodstock were observed to experience low spawning during seasons with elevated temperatures of 31 °C to 33 °C. Meanwhile, a series of experiments showed that female abalone (*Haliotis asinina*) breeders failed to survive by 45 DOC at 33 °C, while only a ratio of males survived by 60 DOC. However, 80 % of the abalone survived when exposed to a more ambient temperature. Lower egg hatching of milkfish, Asian sea bass, and rabbitfish at 30 °C was also observed. In the larval stages, mangrove crab and rabbitfish reared at 33 °C experienced low survival. In the grow-out of tilapia, lower survival was also noted in lake-based cages, where temperatures reached up to 33.2 °C, compared to tilapia in tank-based cages with lower average temperatures.

Along with increasing sea surface temperatures, climate change is also expected to affect the pH level of rearing water because of the increased concentration of carbon dioxide in the atmosphere. The production of natural food is affected by a low pH level. Rotifers and copepods (*Pseudodiaptomus annandalei* and *Acartia tsuensis*) population growth was found to be lower when at pH 7.5. The average pH of the ocean is currently at 8.1.

Aside from these research findings, AQD's Tigbauan Main Station has observed the impacts of sea-level rise which, when compounded with more severe weather events, could severely affect coastal aquaculture facilities.



Storm surge threatening the sea wall of AQD's Tigbauan Main Station in Iloilo, Philippines

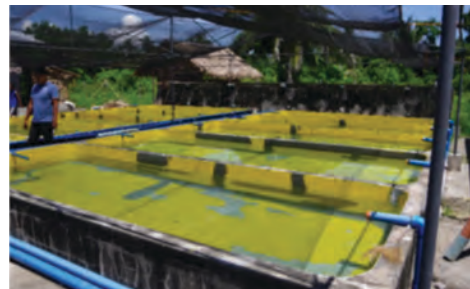
## 2.7 Collaborative projects with the Philippine Government

Since 1973, AQD has developed technologies on broodstock management, seed production, and grow-out of economically-important finfishes, crustaceans, mollusks, and seaweeds. However, the adoption of technology remains to be lagging, problems on the supply of seed, cost of feeds, and diseases are persisting, and technical skills are lacking. To accelerate the application of science-based technologies and approaches, under its Departmental Program “**Collaborative Projects with the Philippine Government,**” AQD has been working in close partnership with the national agencies in the Philippines, the Department’s host country. Together, they aim to address longstanding problems in the aquaculture sector.

### *Fry sufficiency program*

In response to the insufficiency of milkfish (*Chanos chanos*) seeds in the Philippines, the Philippine Department of Agriculture’s Bureau of Fisheries and Aquatic Resources (DA-BFAR) partnered with AQD to construct more hatcheries in the country and revive those that have become unproductive. The Memorandum of Agreement (MOA) signed between DA-BFAR and AQD in 2018 to conduct feasibility studies on the proposed site of government hatcheries have ended in May 2021. Nine feasibility studies out of 16 have been completed, with site evaluation reports and detailed engineering layouts already provided to DA-BFAR. However, the progress of seven other hatcheries was hampered by problems on land ownership and suitability. Hatcheries with no suitable sites to date have been delegated to the regional offices of DA-BFAR.

Meanwhile, DA-BFAR Region VI entered into a new contract with AQD for the feasibility study of six new house bills mandating new hatcheries. Out of six proposed locations, three have already completed feasibility studies. AQD is also working alongside DA-BFAR Region VI and the private sector to revive unproductive hatcheries. So far, a private hatchery in Batan, Aklan and a state college hatchery in Concepcion, Iloilo were reconstructed with assistance from AQD providing training, milkfish larvae, and starters for algal culture. Meanwhile, the hatchery in Batan, Aklan has already successfully started producing milkfish fry.



*Before and after of rehabilitated hatcheries in Batan, Aklan: before (left) and after (right)*



*Before and after of rehabilitated hatcheries in Concepcion, Iloilo: before (left) and after (right)*

### **Development of cost-efficient feeds**

Since 2019, AQD has been testing cost-efficient diet formulations for milkfish and tilapia, using alternative ingredients to replace fish meal which is an expensive and unsustainable resource. The AQD-formulation uses poultry by-products, distillers dried grains solubles, and protein enhanced copra meal which were shown to have potential based on AQD's published research findings. Field testing is being done in different areas in the Philippines in collaboration with the DA-BFAR and NFRDI.

The field testing of cost-efficient feeds for milkfish and tilapia continued in 2021 with field tests completed at the AQD Dumangas Brackishwater Station in Iloilo for tilapia in ponds, at Sto. Tomas, La Union for milkfish in sea cages, and at Agoncillo, Batangas for both milkfish and tilapia in lake cages. The culture runs returned similar results showing that the AQD-formulated diets resulted in better growth of the fish, better survival rate, higher total harvest weight, and better FCR. In 2022, a training course for potential field-testing cooperators will be conducted prior to the rollout of the cost-efficient feeds to their farms.



*Harvest of tilapia from the field testing of feeds at the Dumangas Brackishwater Station of AQD*

### **Oplan Balik Sugpo (Operation Black Tiger Shrimp Revival)**

The tiger shrimp (*Penaeus monodon*) industry continues to struggle to thrive given the persistent occurrence of various shrimp diseases. To facilitate the revival of the industry, AQD launched the *Oplan Balik Sugpo* (Operation Black Tiger Shrimp Revival) program in 2017 with the goal of producing high-quality tiger shrimp postlarvae and promoting the environment-friendly grow-out culture of tiger shrimp.

In 2021, the Shrimp Hatchery Complex of AQD produced 2.08 million postlarvae for the first six months. Some of these were stocked in the brackishwater ponds of the AQD Dumangas Brackishwater Station in June for research and verification purposes, while others were sold to buyers. In October, after 123–126 DOC at the Dumangas Brackishwater Station, a total of 9.6 t of tiger shrimp were harvested in two batches from three ponds totaling 21,303 m<sup>3</sup>. The recorded average body weight was 29–30 g with 80–90 % survival rate.

### ***Accelerated Techno-transfer***

Despite continuing COVID-19 restrictions, the on-site training course for fish farmers was conducted in Roxas City, Capiz in collaboration with DA-BFAR 6, the Office of the Provincial Agriculturist Capiz, and the private sector including cooperatives and businesses. A total of 34 participants composed of pond operators and growers, and individuals from the business sector, attended the training in February. The Training module covered topics on mangrove crab, fish health, shrimp culture, recirculating aquaculture system, and milkfish deboning. Proper health protocols were strictly followed during the Training.

Another training was done online for 95 participants from Kabasalan, Zamboanga Sibugay which were composed of fishers, fish farmers, and local government officers. The Training focused on the importance of conducting a feasibility study and the aquaculture of oyster. Other topics on mangrove crab and grouper were also discussed. The Training was in collaboration with the Mindanao Development Authority, Municipality of Kabasalan, and *Kapunongan sa Gagmay'ng Mangingisda sa Concepcion* of Kabasalan, Zamboanga Sibugay.

Moreover, the online training course on mangrove crab culture was also conducted for the fishers of Bangsamoro Autonomous Region in Muslim Mindanao. A total of 30 fishers from Maguindanao were the beneficiaries of the Training Course. This was in collaboration with the Ministry of Agriculture, Fisheries, and Agrarian Reform, specifically its Fisheries, Coastal Resources, and Livelihood Project.

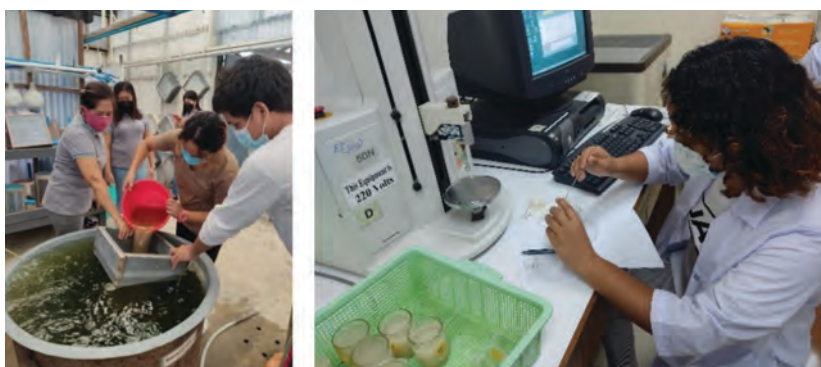


*On-site training course on aquaculture technologies in Roxas City, Capiz, Philippines*



## **Manpower Development**

In 2018, 16 graduates from different fisheries schools around the Philippines were given intensive training on shrimp, marine fish, and tilapia aquaculture. The human resource development training program intends to contribute to a pool of highly-skilled aquaculture personnel that operate aquaculture facilities in the country. Although the COVID-19 pandemic hampered the conduct of subsequent trainings, another batch of trainees was accommodated at AQD from July to October 2021 after hurdling stringent COVID-19 restrictions. The four graduates from different fisheries schools in Mindanao and Bicol area passed the screening process and were given hands-on exposure and training on shrimp, marine fish, mangrove crab, giant freshwater prawn, oyster, seaweed culture, as well as on the operations on brackishwater ponds and cages. Currently, they are assigned at the AQD's Multi-species Marine Fish hatchery, Oyster Hatchery, and Mangrove Crab Hatchery.



*Trainees in action at different AQD Facilities*

### **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 Ready-to-eat Raw Fish and Fishery Products, 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.

In 2021, MFRD continued to carry out activities based on the results from inception meeting in 2020. Under Track 1, MFRD proceeded in MFRD proceeded in engaging an expert to develop the training materials for GMP and GHP of RTE raw fish and fishery products; while under Track 2, MFRD carried out one pilot trial on HPP protocols on a different range of seafood, and engaged a consultant in the conduct of R&D on the seafood.

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

In 2021, there was no project implemented under 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 the 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 developed and implemented by relevant organizations and/or importing countries. The project "**Assistance for Capacity Development in the Region to Address International Fisheries-related Issues**" has therefore been carried out by the SEAFDEC Secretariat with a total duration of four years from 2020 to 2024. The objectives of the project were to monitor the emerging international fisheries-related issues, provide the regional platforms for the AMSs to raise awareness of the emerging international fisheries-related and trade-related issues at various international fora (*e.g.* those of ASEAN, FAO, RFMOs, CITES, WTO, etc.), and subsequently enhance the understanding and capacity of the ASEAN-SEAFDEC Member Countries in addressing such issues. The anticipated deliverables from the discussions could be regional common/coordinated positions and recommendations for national and regional action plans to safeguard regional interests.

However, due to the COVID-19 pandemic, 2021 was another challenging year for various international organizations to organize their respective events. Several important international fisheries-related fora were held virtually due to travel restrictions all over the world. Nonetheless, SEAFDEC continued to participate and provide technical inputs to international fisheries-related virtual events (*e.g.* under ASEAN, FAO, CITES, WESTPAC, etc.) organized in 2021.

In partnership with the ASEAN, SEAFDEC provided the technical inputs at the "13<sup>th</sup> Meeting of the ASEAN Fisheries Consultative Forum (13AFCF)" and the "29<sup>th</sup> Meeting of the ASEAN Sectoral Working Group on Fisheries (29ASWGFi)," hosted by Cambodia on 22 and 23–24 June 2021, respectively. During these two Meetings, SEAFDEC updated the progress and the achievement of the implementation of regional initiatives in addressing the emerging issues that include management of fishing capacity, combating IUU fishing, securing sustainable small-scale fisheries, resource rehabilitation and enhancement, and mitigation of the impacts of climate change on fisheries and aquaculture. Two regional documents endorsed by the SEAFDEC Council, namely: 1) Stock and Risk Assessments of Kawakawa (*Euthynnus affinis*) and Longtail Tuna (*Thunnus tonggol*) Resources in Southeast Asia using ASPIC, and 2) Regional Action Plan for Management of Transboundary Species: Indo-Pacific Mackerel in the Gulf of Thailand Sub-region, were subsequently endorsed by the higher authorities under the ASEAN Mechanism in 2021.



*SEAFDEC joins the 13AFCF and 29AFWGF via virtual meeting*

In 2021, SEAFDEC also participated as an observer at the “34<sup>th</sup> Session of Committee on Fisheries (COFI34)” which was organized virtually by FAO on 1–5 February 2021. The COFI34 key highlights were the marking of the 25<sup>th</sup> anniversary of the Code of Conduct for Responsible Fisheries and the drafting of the Declaration for sustainable fisheries and aquaculture. Moreover, the major agenda of the COFI34 also include 1) the current state of fisheries and aquaculture, 2) impacts of climate change and biodiversity loss, aquaculture biosecurity, and sustainable growth, 3) role of small-scale fisheries and the livelihood of coastal communities, and 4) illegal fishing and fish operations at sea.

Furthermore, SEAFDEC also participated and provided technical inputs at various events organized by other international/regional organizations in 2021 that discussed fisheries-related issues aimed at achieving the sustainable development of fisheries. These include:

- 3<sup>rd</sup> ASEAN Meeting on Combating IUU Fishing in Partnership with the EU (organized by the ASEAN Secretariat in collaboration with the Department of Fisheries, Thailand, 23–24 February 2021, online meeting)
- 36<sup>th</sup> Session of the FAO Asia-Pacific Fishery Commission (APFIC) (organized by FAO/APFIC and hosted by the Department of Fisheries of Thailand, 5–7 May 2021, online meeting)
- FAO E-Technical Working Group (e-TWG) on the Global Record of Stocks and Fisheries (GRSF) (organized by FAO, 30 September–1 October 2021, online meeting)
- FAO Global Conference on Aquaculture Millennium +20: Aquaculture for food and sustainable development (organized by FAO, the Ministry of Agriculture and Rural Affairs (MARA) of the People’s Republic of China, and the Network of Aquaculture Centres in Asia-Pacific (NACA), 22–25 September 2021 in Shanghai, China and online meeting)
- UN Decade Kickoff Conference for Western Pacific and its Adjacent Areas (organized by the Intergovernmental Oceanographic Commission of UNESCO through its Sub-Commission for the Western Pacific (WESTPAC), and the Government of Thailand through its Ministry of Natural Resources and Environment and Department of Marine and Coastal Resources on 25–26 November 2021, online meeting)



*FAO Global Conference on Aquaculture Millennium +20 (22–25 September 2021)*



*E-Technical Working Group (e-TWG) on the Global Record of Stocks and Fisheries (GRSF) (30 September–1 October 2021)*

In preparation for the forthcoming 19<sup>th</sup> Session of the Conference of the Parties to CITES (COP19-CITES) which will be held in 2022 in Panama, SEAFDEC attended the plenary session of the “31<sup>st</sup> Meeting of the Animals Committee (AC31)” held on 31 May–4 June 2021 through videoconference. The Meeting discussed the progress made by the Animals Committee in response to Resolutions and Decisions of the CoP18 which would be reported to the upcoming CoP19 in 2022. The Committee also discussed the conservation and trade status of the selected wild fauna and addressed the technical issues related to the trade of CITES-listed species. The discussion also covered species-specific matters including marine aquatic species, such as sharks and rays, eels, sea turtles, seahorses, Banggai cardinalfish, marine ornamental fishes, and others.



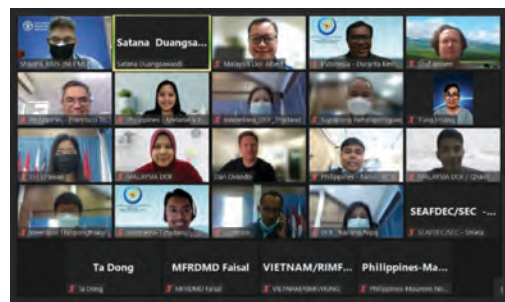
*31<sup>st</sup> Meeting of the Animals Committee (AC31) (31 May–4 June 2021)*

Another important international fish trade-related issue was the discussion under the World Trade Organization (WTO) on fisheries subsidies that has been ongoing since 2001. To facilitate the discussion and exchange of views among the SEAFDEC Member Countries on this matter, SEAFDEC convened the “Webinar on WTO Fisheries Subsidies Draft Consolidated Text (Negotiating Group on Rules)” on 10 and 17 June 2021. Key issues and concerns with regard to the WTO Fisheries Subsidies Draft Consolidated Text (dated 11 May 2021) were presented by the resource persons and Member Countries. SEAFDEC also facilitated the discussion among the countries on the WTO Draft Consolidated Text. However, with the diversity of viewpoints of the Member Countries, the Webinar could not come up with common positions, but only consolidated views of the countries which were subsequently submitted to the SEAFDEC Council *ad referendum*. SEAFDEC also continued to monitor the progress of the discussion on fisheries subsidies. Although WTO targeted to conclude the negotiation of the Agreement on Fisheries Subsidies during its 12<sup>th</sup> Ministerial Conference (MC12), due to the outbreak of a new variant of the COVID-19 virus at the end of 2021, the WTO finally decided to postpone the MC12 to early 2022.



*The Webinar Series on WTO Fisheries Subsidies Draft Consolidated Text on 10 and 17 June 2021*

During the Webinar on fisheries subsidies, SEAFDEC Member Countries raised their concern on the necessity to enhance human capacity on the development of reference points of a key set of fishery resources for proper fisheries management plans considering that the region is characterized by multi-gears and multi-species fisheries. In response to such requirement, SEAFDEC sought support from the FAO to co-host the “Consultative Planning and Training Workshop on Stock Assessment in Support the Implementation of the International Commitments for Sustainable Use of Fisheries Resources in Southeast Asia” on 9 and 13–17 December 2021 at the SEAFDEC Secretariat in Thailand, which was also accessed online by the other AMSs. The resource persons were the experts on fish stock assessment from the FAO, the University of Washington, and the University of Wisconsin, USA. During the Consultative Planning on 9 December 2021, the national experts on stock assessment shared information and views on the level of understanding and knowledge of fish stock assessment methods being used by the countries, as well as discussed the plan for future comprehensive training courses. For the Training session on 13–17 December 2021, 24 participants from the AMSs learned the basic fisheries stock assessment principles, types of data analysis, and simple surplus production models through yield per recruit and age-structured approaches. The participants examined their respective national data and obtained a better understanding of their fish stocks to support the formulation of appropriate fisheries management policies in their country.



*Training Workshop on Stock Assessment in Support the Implementation of the International Commitments for Sustainable Use of Fisheries Resources in Southeast Asia (9 and 13–17 December 2021, Bangkok, Thailand and online meeting)*

Since 2020, the COVID-19 pandemic has created severe effects on the life and economy of all countries and all sectors including fisheries. The Southeast Asian countries are important fisheries producers contributing to food security and economy, therefore, SEAFDEC conducted the “Study on Impacts of COVID-19 Pandemic on the Fisheries Sector of the ASEAN-SEAFDEC Member Countries” with the aim of sharing information among the ASEAN-SEAFDEC Member Countries on the impacts and mitigation of the impacts of the COVID-19 pandemic on the fisheries sector. On 24 February 2021, SEAFDEC organized the virtual “Regional Workshop on the Study on Impacts of COVID-19 Pandemic on the Fisheries Sector of the ASEAN-SEAFDEC Member Countries.” At this Workshop, the National Focal Points of the Study discussed and agreed on the questionnaire that would be used to gather relevant information from the respective countries. As the expected outputs of this study, SEAFDEC would come up with: 1) Report on the impacts of COVID-19 pandemic on the fisheries sector of the ASEAN-SEAFDEC Member Countries; 2) Analysis of long-term implication towards sustainable food security and livelihood (development of Fisheries and Aquaculture: Regional Issues and Policy Responses); and 3) Policy Brief on the impacts of the COVID-19 pandemic on the fisheries sector of the ASEAN-SEAFDEC Member Countries. It was expected that the Study Report would be submitted to SEAFDEC Council during its 54<sup>th</sup> Meeting in 2022.



*Regional Workshop on the Study on Impacts of COVID-19 Pandemic on the Fisheries Sector of the ASEAN-SEAFDEC Member Countries (24 February 2021, online meeting)*

In 2021, the SEAFDEC Member Countries had been preparing for another new fish trade regulation which was issued by the U.S. Government for the exporting countries on the “Implementation of Fish and Fish Product Import Provisions of the Marine Mammal Protection Act,” which would be effective starting 1 January 2023. To facilitate the preparation of countries in the region for such Act, SEAFDEC organized the webinar on “Regional Responses to U.S. Marine Mammal Protection Act” on 2–3 November 2021. The resource persons from the NOAA Fisheries Service and INFOFISH presented the overview and highlights on major issues related to the exportation of fish and fishery products from Southeast Asian countries to the U.S., and trade information on fish and fishery products focusing on products exported from the AMSs to the U.S. Moreover, the Member Countries were also updated on the Implementation of Fish and Fish Product Import Provisions of the MMPA and Applicability for Comparability Finding which would be effective on 1 January 2023. To support the countries in implementing the U.S. MMPA, technical assistance for capacity building would be provided by the U.S., SEAFDEC, and relevant international/regional organizations.



*Webinar on Regional Responses to U.S. Marine Mammal Protection Act (2–3 November 2021)*

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

Gender is recognized as one of the crucial issues that need to be addressed in many workplaces including in the fisheries sector. Especially in small-scale fisheries of the Southeast Asian region, women and men were 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 recommend 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 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 the 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 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 activities to promote gender in fisheries in Southeast Asia. The four participating countries for this Project were Lao PDR, Myanmar, Philippines, and Thailand. The original duration of this Project was from 1 January 2020 to 30 June 2021, however, the Project was extended until 31 December 2022 considering that the activities could not be completed within the original timeline due to the COVID-2019 situation.

In 2020, despite the COVID-19 situation, TD was able to complete the activities in Surat Thani Province, Thailand for marine fisheries, and started the conduct of activities in



Bolikhamxay Province, Lao PDR for inland fisheries. In 2021, the activities were therefore continued in Lao PDR and commenced in Myanmar and Philippines.

In **Lao PDR**, after the “Site Training for Enumerator on Gender Concept and Analysis and Development of a Data Collection Protocol” conducted in Bolikhamxay Province in 2020, TD continued the activities in 2021 by conducting the data collection and analysis on 25–29 January 2021. This was followed by the data validation workshop with local stakeholders on 22 March 2021 to verify the results from data collection.



*Data Collection and Analysis on Gender Dimension in the Value Chain of Small-scale Fisheries and Aquaculture were conducted in Lao PDR (25–29 January 2021)*

For **Myanmar**, TD organized the “Site Training for Enumerators on Gender Concept and Analysis through Development of a Data Collection Protocol” from 18 to 20 May 2021 in Nay Pyi Taw for 13 fisheries officers from the Department of Fisheries Myanmar. The aim of the Training was to enhance the understanding and skill of gender analysis of fisheries officers for them to apply in the pilot site. Subsequently, data collection and analysis were conducted on 24–28 May 2021 in Kyauktan, Yangon where 40 fishers engaged in small-scale inland capture fisheries were interviewed; and this was followed by the data validation workshop on 29 June 2021, also in Kyauktan, Yangon, with 54 participants including local fishers and other stakeholders.



*Site Training for Enumerators on Gender Concept and Analysis through Development of a Data Collection Protocol for Myanmar (18 to 20 May 2021 in Nay Pyi Taw)*



*Data Collection and Analysis on Gender Dimension in the Value Chain of Small-scale Fisheries and Aquaculture were conducted in Myanmar (24–28 May 2021)*

As for the *Philippines*, the “Site Training for Enumerators on Gender Concept and Analysis through Development of a Data Collection Protocol” was organized on 23–25 June 2021 in Infanta, Quezon and this was participated by 17 fishery officers from DA-BFAR. Data collection and analysis were subsequently conducted on 16–19 November 2021.

## **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 a better understanding of the marine fishery resources in their respective waters. This had been facilitated through the ongoing project of TD “**Fisheries Resource Survey and Operational Plan for M.V. SEAFDEC 2.**”

Three cruises were planned to be carried out in 2021 using the M.V. SEAFDEC 2, namely: 1) Comparison on the Catch Per Unit Effort of Fisheries Resources by Trawling between the Research Vessels of SEAFDEC/TD and the Department of Fisheries Thailand in the Gulf of Thailand (six expected service days); 2) Marine Fisheries Resources, Environmental and Marine Debris Research Survey in the Gulf of Thailand (47 expected service days); and 3) Marine Environmental and Fishery Resources Survey in the Gulf of Thailand (expected 47 service days). However, due to the continued COVID 19 pandemic in 2021, TD postponed the three cruises to 2022.

Although the M.V. SEAFDEC 2 was not actively operated in 2021, significant achievement was made in upgrading the M.V. SEAFDEC 2 by equipping the vessel with the new scientific echosounder (SIMRAD EK-80) with support from the Japanese Trust Fund. It is expected that this equipment would serve as an efficient tool for the Member Countries to investigate the abundance of pelagic resources as well as obtain accurate data on fishery resources to support better management of fisheries in the future. SEAFDEC would continue to utilize the M.V. SEAFDEC 2 to support shipboard survey for stock assessment of small pelagic fishery resources of the requesting Member Countries in the future (*see 1.6, sub-topic on Improvement of Fisheries Technology and Reduction of the Impact from Fishing Activities*).

### **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***

The South China Sea (SCS) supports a number of unique habitats and ecosystems that are among the most biologically diverse shallow-water marine ecosystems globally. The richness and productivity of the SCS and associated environments are, however, seriously

threatened by high human population growth, pollution, overharvest, and habitat modification resulting in high rates of habitat loss and impairment of the regenerative capacities of living resources. The socioeconomic impacts of environmental deterioration are significant for the economies of this region. Recognizing that actions were urgently needed to halt the degradation of the environment of this marine basin, the countries of the region sought the assistance of UNEP and GEF and the project “Reversing Environmental Degradation Trends in the South China Sea and Gulf of Thailand” was implemented from 2003 to 2008. This included the Transboundary Diagnostic Analysis of the issues and problems and their societal root causes as the basis for the development of a Strategic Action Programme (SAP) which was inter-governmentally adopted in 2008. The SAP established a series of objectives and priority costed actions for coastal habitats, land-based pollution management, and the overexploitation of fish stocks in the SCS.

In order to provide assistance to countries in meeting the targets of the adopted SAP through the implementation of the National Action Plans in support of the SAP and strengthening regional coordination for SCS SAP implementation, the project “**Implementing the Strategic Action Programme for the South China Sea and Gulf of Thailand**” or the “SCS SAP Project” was formulated with the United Nations Environment Programme (UNEP) with GEF as the implementing agency. Implemented in six participating countries, namely: Cambodia, China, Indonesia, Philippines, Thailand, and Viet Nam, the Project comprises three components including: 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 Project is executed by the United Nations Office for Project Services (UNOPS) and SEAFDEC together with the environment ministries of the participating countries.

In 2021, the SCS SAP Project was able to initiate actions and activities at the national and regional levels in spite of the challenges of COVID-19. National teams of the participating countries organized their respective internal coordination and consultations with concerned agencies and institutions to discuss the Project and implementation phase activities. These included confirmation of national focal points of different Project bodies including the Specialized Executing Agencies; review and confirmation of intervention sites and targets; and review and updating of the draft National Implementation Report (NIR), which will be the basis for national execution of activities. The draft NIRs were however still in different stages of completion by participating countries.

At the regional level, the Project organized bilateral meetings and calls with national teams to guide and provide details of the implementation phase activities, and with implementing and executing agencies and regional projects and partners on the progress of the Project and possible synergies and collaboration including participation in international and regional meetings and events such as the 25<sup>th</sup> COBSEA Intergovernmental Meeting and the 44<sup>th</sup> SEAFDEC Program Committee Meeting, and regular updating of Project website (scssap.org). The Note on Implementation Procedures between UNOPS and SEAFDEC detailing the roles and responsibilities and implementation arrangements has been finalized and awaiting the signature of all parties.

Three key activities were organized in 2021 which include the “First Meeting of the SCS SAP Project Steering Committee” on 29–30 June 2021 to present and discuss the Inception Phase Regional Report and implementation arrangements including the workplan and budget. This was followed by the “SCS SAP Project Inception Workshop” on 1 July 2021 to launch the Project with the participating countries and key partners. Four Regional Working Group Meetings for Mangroves (1 December 2021), Coral Reefs (2 December 2021), Seagrass (3 December 2021), and Wetlands (7 December 2021) were organized and participated in by the national committee chairs and representatives of each working group including national project teams and experts to present and discuss the SAP targets particularly the status of SAP implementation from 2008–2020, and the status and progress of the SCS SAP Project implementation. From the working group presentations, it was evident that significant progress had been achieved in SAP implementation since its adoption in 2008 in terms of the declaration of sites with protection and conservation status, development and implementation of management plans including restoration in sites, and adoption of policy and legislative reforms, among others. Also, the SCS SAP Project co-organized with the IOC/UNESCO and MSP global Project the Virtual Dialogue on Marine Spatial Planning for the South China Sea and Gulf of Thailand Large Marine Ecosystems on 15 December 2021, participated mostly by the members and participants of the SCS SAP Regional Working Group meetings and partners.

As the executing agency responsible for regional activities, SEAFDEC has continuously provided support to the SCS SAP Project on project management and administration such as the hosting of the Project office, recruitment of Project staff to provide technical and administrative support, technical and logistical support in organizing regional meetings, procurement of office supplies and equipment, engagement of auditing company, and reporting of co-financing contribution to the Project.

### **6.3 Enhancing human resources within the SEAFDEC organization**

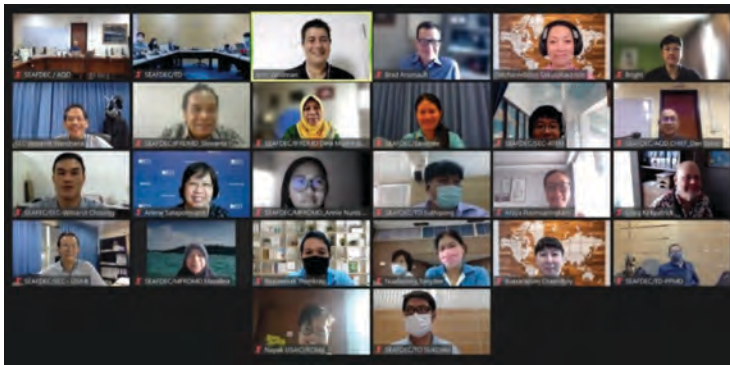
#### ***SEAFDEC Capacity Development through the USAID Sustainable Fish Asia Activity***

SEAFDEC Capacity Development under Sustainable Fish Asia (SUFIA) Support Project was launched in September 2020 with the funding support of the United States Agency for International Development Regional Development Mission for Asia (USAID/RDMA) for two years. This Project aims to improve the management of marine biodiversity and fishery resources in Southeast Asia and Pacific regions by reducing unsustainable and IUU fishing. The Project is implemented by the Research Triangle Institute (RTI) International with two main tasks, namely: Task 1 – organizational capacity assessment (OCA) and customized capacity development services for SEAFDEC; and Task 2 – private sector landscape assessment (PLSA) to identify gaps in for possible collaboration with private sectors within fisheries sector in the region. In addition, the Project also comprises cross-cutting activities on the development of communication and outreach products.

For Task 1, organizational capacity assessment activities were conducted from January to March 2021 using the Participatory Local Organizational Capacity Assessment (PLOCA) e-survey, Non-US Organization Pre-Award Survey (NUPAS), and Organizational Performance Index. The results from such surveys were used to develop the Capacity Development Action Plan (C-DAP). Subsequently, the Capacity Strengthening Initiative (CSI) Subaward was given

to SEAFDEC, comprising three main activities, *i.e.* 1) Improvement of administration and financial management system, 2) Improvement of human resources management, and 3) Process documentation of all activities conducted for monitoring, evaluation, and learning to enhance the capacities of SEAFDEC for compliance with the USAID's requirements.

In parallel with the activities under Task 1 that help enhance the capacities of SEAFDEC, SEAFDEC together with the RTI and USAID conducted the "Co-creation Workshop" on 11–12 November 2021 as a process to develop a project for a direct grant from the USAID. Attended by the SEAFDEC Secretary-General, Department Chiefs, officers from SEAFDEC Secretariat and Departments, as well as representatives from USAID/RDMA and RTI International, the Workshop came up with the initial draft of the PIO Grant Activity Description Document which would be further finalized and submitted by SEAFDEC to the USAID/RDMA.



*The online co-creation workshop convened on 11–12 November 2021*

As for Task 2, the Private Sector Landscape Assessment Survey was conducted and completed in March 2021 followed by consultations with key stakeholders. The "Private Sector Engagement (PSE) In-Briefing Session" was convened on 22 March 2021 to update SEAFDEC on the PSE Survey's results. The Session was attended by the SEAFDEC Secretary-General, senior officials from SEAFDEC Departments and Secretariat, as well as representatives from the USAID/RDMA and RTI International. The Session discussed the results of the PSE Survey and the next steps regarding the identification of the private sector partnership opportunities and concept notes. From April to June 2021, TD developed five concept notes for possible collaboration with the private sector, namely: 1) Baan Nai Nang Ecosystem Approach to Fisheries Management Support Project, 2) Mangrove Crab Bank Pilot, 3) Comparative Study to Reduce Trawler Gear Negative Impacts, 4) Sandfish and Sea Cucumber Stock Assessment, and 5) Automatic Catch-Data Software using Artificial Intelligence (AI). At the end of 2021, consultations with the prospective collaborating the private sector were still ongoing.

## SEAFDEC PROGRAMS FOR 2022

During the Forty-fourth Meeting of the SEAFDEC Program Committee (15–17 November 2021, online meeting), the programs and projects to be implemented by SEAFDEC in 2022 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 ongoing and 4 new projects); 2) Departmental Programs (10 programs); and 3) Other Programs (4 programs). The list and description of programs and projects in 2022 appear as follow:

### 1) Projects under the FCG/ASSP Mechanism

#### *Ongoing Projects*

| Strategy/Project Title  | Lead Department | Funding Source |
|---|-----------------|----------------|
| <b>Strategy I: Securing the sustainability of fisheries to contribute to food security, poverty alleviation and livelihood of people in the region</b>  |                 |                |
| <p>1. Strengthening a Regional Cooperation and Enhancing National Capacities to Eliminate IUU Fishing in Southeast Asia (2020–2024)</p> <p>The Project has the objective of promoting the regional tools, namely: the Database on Regional Fishing Vessels Record (RFVR) and the electronic ASEAN Catch Documentation Scheme (eACDS), and enhancing regional cooperation to support the implementation of Port State Measures (PSM) with a view of preventing the entry of fish and fishery products from IUU fishing into the supply chain. In 2022, the Project would follow up, monitor, and facilitate the uploading by the AMSs of the key data elements to the RFVR database, while the regional meeting to share information on MCS would be organized. The Project would also continue to implement, trial, monitor, and transfer the eACDS application for Brunei Darussalam, Viet Nam, Malaysia, Myanmar, and other countries as required. Moreover, the Project will continue to enhance national capacities and update information on combating IUU fishing and strengthen coordination with other partners including participating in international/regional meetings/workshops relevant to IUU fishing.</p> | TD              | JTF            |
| <p>2. Harmonization and Enhancing Utilization of Fishery Statistics and Information (2020–2024)</p> <p>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. In 2022, SEAFDEC will organize the 2<sup>nd</sup> RTC on Fishery Statistics and Information to discuss areas for improvement/incorporation in the revised Regional Framework on Fishery Statistics in</p>  | SEC             | JTF            |

| Strategy/Project Title   | Lead Department | Funding Source |
|--|-----------------|----------------|
| <p>Southeast Asia. Moreover, the publication Southeast Asian State of Fisheries and Aquaculture (SEASOFIA) prepared by the SEAFDEC Departments with inputs from the AMSs and in consultation with the National Coordinators of the AMSs will be launched during the 54<sup>th</sup> Meeting of SEAFDEC Council in 2022. Meanwhile, the annual publication “Fish for the People” Volume 20 with three issues in 2022 would be also sustained under this Project.</p>  |                 |                |
| <p>3. Responsible Fishing Technology and Practice (2020–2024)</p> <p>The Project aims to promote responsible fishing technologies and practices in Southeast Asia that would minimize the impacts of fishing activities on the fishery resources and the marine ecosystems. In 2022, the activities would be emphasized on abandoned, lost or otherwise discarded fishing gears (ALDFG) and fishing gear marking. Webinars and technical workshops will be organized to support capacity development for the Member Countries, while study on the lost fishing gear and/or fishing gear marking would be undertaken in collaboration with participating countries. Another focus of the Project would be on energy optimization. The Project plans to conduct a training course on an energy audit to improve fuel consumption, carbon emission as well as safety in fishing operations; while research and training courses on appropriate fish handling techniques system for purse seiner, <i>i.e.</i> sherbet ice system, would be conducted. In addition, the Project would also promote and disseminate information on techniques to manage fuel consumption, carbon emission, safety of the fishing operations, and fish handling techniques onboard fishing vessels.</p> | TD              | JTF            |
| <p>4. Research for Enhancement of Sustainable Utilization and Management of Sharks and Rays in the Southeast Asian Region (2020–2024)</p> <p>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 conduct of socioeconomic studies in selected sites using multifactor partitioning analysis. In 2022, MFRDMD would conduct one training course and workshop on chondrichthyan taxonomy and biology, and one on-site training on taxonomy and biology at selected landing sites in Viet Nam. TD and MFRDMD would continue to support landing data collection at selected participating countries. The study on stock structures of two shark species (<i>C. hasseltii</i> and <i>C. sorrah</i>) and one CITES-listed species (<i>S. lewini</i>), and a survey on fishers’ dependencies, marketing, and trade of sharks and rays in Pontianak, Indonesia would be also continued.</p>   | MFRDMD          | JTF            |

| Strategy/Project Title  | Lead Department | Funding Source |
|---|-----------------|----------------|
| <p>5. Sustainable Utilization of Anguillid Eels in the Southeast Asian Region (2020–2024)</p> <p>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 the genetic population structure of tropical eels in Southeast Asia, tissue samples would be collected from Indonesia, as well as in other countries, such as Philippines, Viet Nam, and Myanmar. Laboratory work would be also conducted to analyze the genetic population structure of tropical anguillid eels. Although the survey activities planned in 2021 could not be undertaken due to the COVID-19 pandemic, the Project activities would recommence in 2022 with the conduct of a survey to collect catch and biological data. The survey would contribute to the sustainable management of eel fisheries and standardize the data collection system in the Member Countries. The genetic survey would be also continued to identify the genetic population structure of tropical anguillid eels in Southeast Asia by using a D-LOOP region marker. The samples and/or tissues of <i>Anguilla marmorata</i> would be collected and analyzed in the selected Member Countries that have <i>A. marmorata</i> (i.e. Indonesia, Philippines, Viet Nam, and Myanmar). Meetings would be conducted twice a year to confirm the progress and improvement of each activity. The achievement of the study would be evaluated by experts at the end of 2022.</p> | IFRDMD          | JTF            |
| <p>6. Sustainable Utilization of Fisheries Resources and Resources Enhancement in Southeast Asia (2020–2024)</p> <p>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 the monitoring of marine fishery resources and environment; and sustain resource enhancement through the establishment of artificial habitats. In 2022, the planned activities under this Project are 1) Training Course on Marine Debris and Microplastic Survey and Analysis; 2) Training Course on GIS for Marine Resources Management; 3) Training Course on Fish Larvae Identification and Determining Spawning-nursing Ground and Season Using Larvae Survey Results; and 4) Support researchers of the Member Countries</p>  | TD              | JTF            |



| Strategy/Project Title   | Lead Department | Funding Source |
|--|-----------------|----------------|
| to participate in the onboard survey. In addition, the Project would also encourage the Member Countries to carry out national fisheries and marine environmental surveys, and to support SEAFDEC staff and researchers of the Member Countries in participating in seminars, meetings, or workshops in order to disseminate knowledge and Project results.  |                 |                |
| <p>7. Fisheries Management Strategies for Pelagic Fish Resources in the Southeast Asian Region (2020–2024)</p> <p>With the participating countries, namely: Brunei Darussalam, Cambodia, Indonesia, Malaysia Myanmar, Philippines, Thailand, and Viet Nam, the Project aims to support stock and risk assessment of 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 on neritic tuna species in the region. In 2022, the Project would continue to collect and compile regional information for stock and risk assessment of target small pelagic fishes (<i>Rastrelliger kanagurta</i>, <i>R. brachysoma</i>, <i>Decapterus</i> spp.) and neritic tunas (<i>Thunnus tonggol</i> and <i>Euthynnus affinis</i>). Furthermore, the Core Expert Meeting would be arranged to discuss the current status of target pelagic species/groups in the South China Sea and Andaman Sea and gather opinions and recommendations from the participating AMSs on the Project’s future plans. This Project would also continue the study on the genetic structure of <i>E. affinis</i> including samples stored by the Research Institute of Marine Fisheries (RIMF), Indonesia. Necessary equipment and samples for those studies would be acquired. Data analysis for samples collected from 2020 to 2021 would be conducted to confirm the age group of <i>E. affinis</i>.</p> | MFRDMD          | JTF            |
| <p>8. Management Scheme for Inland Fisheries in the Southeast Asian Region (2020–2024)</p> <p>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. The first is aimed at improving the fishers’ livelihood program by developing guidelines for international fisheries management and dissemination to governments and other relevant agencies in Southeast Asia; while the second is aimed at assembling fish catch data and information by establishing a catch database and profiles of freshwater fish biodiversity and developing a draft of manual on Fish Biological Sampling Method. Indonesia and Cambodia will be the site locations in 2022, but subject to the COVID-19 situation. The activities for Output 1 consist of seeking and identifying the major component of conservation management and some training. While the activities for Output 2 consist of collecting catch data and profiles of freshwater fish biodiversity.</p>   | IFRDMD          | JTF            |

| Strategy/Project Title   | Lead Department              | Funding Source |
|--|------------------------------|----------------|
| <p>9. Small-scale Fisheries Management for Better Livelihood and Fisheries Resources (2020–2024)</p> <p>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 2022, three main activities would be carried out which include 1) Implementation of EAFM for improving livelihood and well-being of fishers at each site by the EAFM core team in the respective countries; 2) Capacity development of the SSF team of TD and key officers of the Member Countries in the implementation of the SSF guidelines for improving the livelihood and well-being of the small-scale fishers; and 3) Further promotion of gender integration and empowerment in sustainable fisheries management in the Member Countries.</p>  | TD                           | JTF            |
| <p>10. Establishment and Operation of a Regional System of Fisheries <i>Refugia</i> in the South China Sea and Gulf of Thailand (2016–2020, extended to June 2023)</p> <p>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 <i>refugia</i> in the South China Sea and the Gulf of Thailand for improved management fisheries and critical marine habitats linkage. The Project comprises four components, namely: 1) Identification and management of fisheries and critical habitat linkages at priority fisheries <i>refugia</i> 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-based for fisheries <i>refugia</i> management in the South China Sea; 3) Information Management and Dissemination in support of national and regional-level implementation of the fisheries <i>refugia</i> 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. 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 with the technical closure in 2022.</p> | TD                           | UNEP/GEF       |
| <p>11. Strengthening the Effective Management of Inland Fisheries and Aquaculture in AMS with GIS and RS Technology (2019–2020, extended to 2022)</p> <p>This Project was implemented starting in 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 the AMSs through the use of GIS and RS. This Project was</p>  | SEC in collaboration with TD | JAIF           |

| Strategy/Project Title   | Lead Department                  | Funding Source |
|--|----------------------------------|----------------|
| <p>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 duration was extended until 2022. In 2022, the activities would include 1) Compiling and processing catch data from AMS and creating a database for analysis; 2) Collection of environmental data (inland water area, water temperature, rainfall, and chlorophyll, etc.) for the sites, editing/processing them, and creating a database for analysis; 3) Analysis of the relationship between catch data and environmental data using multivariate analysis methods; and 4) Preparation of technical manual showing how to analyze using GIS mapping/remote sensing techniques, and a final project report. Moreover, a workshop would be organized on techniques for analyzing catch data and environmental data using GIS and RS to disseminate the technology to the AMSs.</p>  |                                  |                |
| <p>12. Development of Stock Assessment Methods and Strengthening of Resources Management Measures for Tropical Anguillid Eel in Southeast Asia (2020–2021, extended to 2022)</p> <p>The Project started in 2020 and focused on the collection of catch data and biological/ecological information for the estimation of eel stocks, and development of mathematical/statistical methods for estimating tropical anguillid eel stocks that could be used for the formulation of effective management measures for the sustainable use of tropical anguillid eels in Southeast Asia. In 2022, IFRDMD would continue the activities to establish the system for the collection of statistical data on catch and aquaculture of tropical anguillid eels, and the 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 catches and fishing efforts, 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. Moreover, the methods would be developed to assess eel stock by analyzing catch and fishing effort data.</p> | SEC in collaboration with IFRDMD | JAIF           |
| <p><b>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</b></p>  |                                  |                |
| <p>13. Sustainable Aquaculture through Cost-Effective Culture Systems, and Prompt and Effective Aquatic Animal Health Management (2020–2024)</p> <p>The Project aims to attain: 1) sustainable aquaculture through cost-effective culture systems, and 2) prompt and effective aquatic animal health management schemes. For the first objective, activities in 2022 include 1) Construction of the hatchery that encourages the <i>in-situ</i> enhancement of aquaculture skills and entrepreneurial competencies of giant freshwater prawn (GFWP)</p>  | AQD                              | JTF            |

| Strategy/Project Title   | Lead Department | Funding Source |
|--|-----------------|----------------|
| <p>farmers in Laguna Lake and tributaries, and in ponds in lakeshore areas; 2) Feeding trials to test the effects of fisheries and agricultural wastes and by-products blend in diets for improved growth performance of GFWP postlarvae in biofloc and clear water conditions; 3) Earthen pond experiments to determine the efficiency of the designed artificial/constructed wetland in a recirculating aquaculture system identified in the mesocosm experiment in mitigating the effect of diseases; and 4) Collection of sample collection and development of fish handling and transportation techniques to ensure live fish stocks, including appropriate maintenance technique of broodstock and hatching protocol for wild-sourced slipper lobster, and larval rearing methods for flathead lobster. For the second objective, the Project would focus on the monitoring and surveillance of mass mortalities in aquaculture caused by unknown and emerging crustacean and fish diseases, including EHP and WSSV. This enables to isolate and identify the causative agent(s) and develop disease diagnostic protocol(s). However, if COVID-19 travel restrictions are still implemented by 2022, the Project would only focus on conducting farm visits and samplings within the province/region in the Philippines. A number of on-site/station-based training would be conducted, <i>i.e.</i> on marine aquaculture, community-based freshwater aquaculture, feed development and management practices, and management of aquatic animals.</p> |                 |                |
| <p><b>Strategy III: Ensuring the food safety and quality of fish and fishery products for the Southeast Asian region</b></p>   |                 |                |
| <p>14. Enhancing Food Safety and Competitiveness of Seafood Products (2020–2024)</p> <p>The Project is aimed at improving food safety and competitiveness of seafood products in the Southeast Asian region through the conduct of training workshops and development of guidelines, with support from regional technical experts. The Project comprises two scopes including 1) Development of regional standards and guidelines on Good Manufacturing and Handling Practices (GMP&amp;GHP) for Ready-to-Eat (RTE) raw fish and fishery products; and 2) Introduction of High-Pressure Processing (HPP). Under the first scope, the activities in 2022 on the conduct of GMP &amp; GHP pilot trials by the respective AMSs would proceed after the development of training materials and conduct of regional training course on GMP &amp; GHP for fish and fishery products in 2021. For the second scope on HPP of fish and fishery products, it is expected that a pilot trial would be conducted at an HPP facility in Singapore; while training materials and Handbook of HPP on fish and fishery products would be developed.</p>  | MFRD            | JTF            |
| <p><b>Strategy IV: Enhancing trade and compliance of the region's fish and fishery products with market requirements</b></p>   |                 |                |
| <p><i>No project under this Strategy in 2020</i></p>   |                 |                |

| Strategy/Project Title   | Lead Department | Funding Source  |
|--|-----------------|---|
| <b>Strategy V: Addressing cross-cutting issues, such as labor, gender and climate change, where related to international fisheries</b>   |                 |   |
| <p>15. Assistance for Capacity Development in the Region to Address International Fisheries-related Issues (2020–2024)</p> <p>The Project aims to ensure the sustainable utilization and sound management of fishery resources through appropriate regional approaches in the international fish trade. In 2022, SEAFDEC would continue to support SEAFDEC staff to participate in the relevant regional/international fora <i>e.g.</i> those of FAO, CITES, others, and would update the status of the international fish trade-related issues by providing regional platforms (<i>e.g.</i> regional technical consultations, webinars, workshops) for the AMSS to discuss international fish trade-related issues (<i>e.g.</i> CITES, Marine Mammal Protection Act of the United States of America, among others), which may create impacts on the development of fisheries and aquaculture in the Southeast Asian region. This Project would also support fisheries officers from the AMSS by conducting the Regional Capacity Building Network (RECAB) subject to the COVID-19 situation in 2022.</p>  | SEC             | JTF   |
| <b>Strategy VI: Empowering SEAFDEC to strengthen its roles in the region and to improve its services to Member Countries</b>   |                 |   |
| <p>16. Fisheries Resource Survey &amp; Operational Plan for M.V. SEAFDEC 2 (since 2004)</p> <p>The M.V. SEAFDEC 2 was granted by the Government of Japan in 2004 to support fisheries resources and marine environmental surveys of the Member Countries. 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 2022, TD plans to conduct three cruises by using M.V. SEAFDEC 2, namely: 1) Comparison of the Catch Per Unit Effort of Fisheries Resources by Trawling between the research vessels of TD and the Department of Fisheries Thailand in the Gulf of Thailand (six service days, scheduled in March 2022); 2) Marine Fisheries Resources, Environmental and Marine Debris Research Survey in the Gulf of Thailand (47 service days, scheduled from April to June 2022); and 3) Marine Environmental and Fishery Resources Survey in the Gulf of Thailand (expected 47 service days, scheduled from September to October 2022). Moreover, a biomass survey of sardine resources in selected areas in the Philippines is also planned using the M.V. SEAFDEC 2 in 2022.</p> | TD              | JTF, with cost sharing from AMSS requesting to use the vessel |

**New Projects**

| Project Title   | Lead Department                            | Funding Source |
|---|--|----------------|
| <p>1. ASEAN–JICA Cooperation for Capacity Building on IUU Fishing Countermeasures in Southeast Asia (2022–2024)</p> <p>This Project was scheduled to commence in 2021 but postponed to 2022. 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 2022, TD would organize the Regional 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, the Regional Capacity Building Workshop on Enhancing Policies and Countermeasures Against IUU Fishing in Southeast Asia would also be conducted.</p>   | TD   | JICA           |
| <p>2. ASEAN–JICA Food Value Chain Development Project (2022–2024)</p> <p>The commencement of this Project which was scheduled to in 2021 was postponed to 2022. The ASEAN–JICA Food Value Chain Development Project is composed of four 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 2022 include 1) Training course on GAqP in marine fish aquaculture; 2) Regional workshops on 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.</p> | SEC in collaboration with TD, AQD and MFRD | JICA           |
| <p>3. Regional Collaborative Research and Capacity Building for Monitoring and Reduction of Marine Debris from Fisheries in Southeast Asia (2022–2023)</p> <p>This Project was originally scheduled to commence in 2021 but was postponed to 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 as well as monitoring the four priority areas of the “ASEAN Framework of Action on Marine</p>   | TD   | JAIF           |

| Project Title   | Lead Department | Funding Source |
|---|-----------------|----------------|
| <p>Debris.” The activities under this Project include 1) Gathering of information to estimate the amount of ALDFG and monitoring of ALDFG at accumulated pilot sites and development of removal guidance of ALDFG; 2) Conducting workshop on information exchange and development of technical guidance on ALDFG countermeasures; 3) Conducting survey on marine environment and fishery resources using a research vessel, and evaluating the impacts of microplastics on fisheries resources in the Gulf of Thailand; 4) Conducting research and evaluation on the amount of marine debris collected by different types of fishing gears during the fishing activities at sea; 5) Investigating and conducting risk assessment of microplastics in freshwater fish and marine fish, and disseminating the results on contaminants of microplastics at the pilot sites in the Gulf of Thailand for marine fish and at the Musi River, South Sumatra, Indonesia for freshwater fish; 6) Conducting on-the-job training on reliable research methods on marine debris and microplastics for officers and researchers from the AMSs; 7) Conducting of the Regional Symposium on Marine Debris and Microplastics in Fisheries in Southeast Asia; 8) Developing the Project website and communication materials; and 9) Developing the technical manual for marking of fishing gears.</p> |                 |                |
| <p>4. 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 (2022–2026)</p> <p>The overall objective of this Project is to contribute to the sustainable management of fisheries, marine living resources, and their habitats in the Bay of Bengal region for the benefit of coastal states and communities. The Project would be implemented by SEAFDEC together with other organizations, <i>i.e.</i> IUCN and BOBP-IGO, in participating countries, namely: Bangladesh, India, Indonesia, Malaysia, Maldives, Sri Lanka, and Thailand. The Project components comprise 1) Sustainable management of fisheries; 2) Restoration and conservation of critical marine habitats and conservation of biodiversity; 3) Management of coastal and marine pollution to improve ecosystem health; 4) Improved livelihoods and enhanced resilience of the BOBLME; and 5) Regional mechanism for planning, coordination, and monitoring of the BOBLME.</p>  | TD              | FAO/GEF        |

## 2) Departmental Programs

| Program Title  | Department | Funding Source |
|--|------------|----------------|
| <p>1. Quality Seed for Sustainable Aquaculture (<i>ongoing</i>)</p> <p>The Program aims to generate, verify, and promote technologies to ensure the sustainable production of quality seed stocks for aquaculture and for stock enhancement.</p> <p>In 2022, the Program would continue to undertake the following activities:</p> <ul style="list-style-type: none"> <li>• Precocious puberty in milkfish through endocrine manipulation</li> <li>• Use of andrectomized males (neo-females) giant freshwater prawn (<i>Macrobrachium rosenbergii</i>) for the production of all-male progenies</li> <li>• Verification of adequate feeding rations and use of algal paste for single seed spat production of slipper-shaped oyster <i>Crassostrea iredalei</i></li> <li>• Economic viability of tank-based polychaete culture technology</li> <li>• Use of microalgal paste-fed <i>Proales similis</i> in marine fish larviculture: I. Refinement of <i>P. similis</i> mass production schemes II. Assessment of <i>P. similis</i> as the first food for marine fish larvae</li> <li>• Development of a protocol for large-scale culture of harpacticoid copepods for marine fish larviculture</li> <li>• Seed production of donkey's ear abalone <i>Haliotis asinina</i> juveniles</li> <li>• Seed production of freshwater prawn <i>Macrobrachium rosenbergii</i></li> </ul> | AQD        | AQD*           |
| <p>2. Healthy and Wholesome Aquaculture (<i>ongoing</i>)</p> <p>The Program has two main components: 1) Fish Health; and 2) Nutrition and Feed.</p> <p>The “Fish Health Component” aims to improve aquaculture production through innovations in aquaculture nutrition and feeding, and fish health management as well as maintain the environmental integrity of aquaculture systems. The activities in 2022 would include:</p> <ul style="list-style-type: none"> <li>• Detection, quantification, and viability of Tilapia Lake Virus (TiLV) in pond soil and water as influenced by water quality parameters and culture management</li> <li>• Detection, control, and treatment of persistent and emerging pathogens affecting pond cultured Asian catfish (<i>Clarias macrocephalus</i>)</li> </ul>  | AQD        | AQD*           |



| Program Title  | Department | Funding Source |
|--|------------|----------------|
| <ul style="list-style-type: none"> <li>• Field verification of the vaccination regimen in cage-cultured marine fish species (pompano, snapper, grouper) broodfish at the Igang Marine Station as a practical strategy to prevent the vertical transmission of nervous necrosis virus during seed production</li> <li>• Pilot field trials to evaluate emamectin benzoate, hydrogen peroxide, and freshwater bath to reduce a natural infestation of sea lice on snub-nose pompano <i>Trachionotus blochii</i></li> <li>• Safeguarding the future of the seaweed industry of the Philippines particularly disease and pest detection</li> <li>• Identification of risk factors of diseases of different aquaculture species (<i>i.e.</i> bacterial diseases in finfish, diseases of seaweeds) and the treatment for these diseases</li> </ul> <p>The “Nutrition and Feed Component” aims to: 1) find effective alternative protein sources to fish meal in dietary formulations; 2) determine specific nutrients that enhance growth performances; and 3) promote practices and strategies to improve production. The activities in 2022 would include:</p> <ul style="list-style-type: none"> <li>• Cost-effective ingredient blend of soybean meal, corn protein concentrate, poultry by-product meal, and hemoglobin meal and protein enhanced copra meal in the diets of pompano, <i>Trachinotus blochii</i></li> <li>• Development and evaluation of fungi-fermented feed ingredients as alternative protein sources for milkfish diet</li> <li>• Production techniques for the culture of silver therapon (<i>Leiopotherapon plumbeus</i>) in tanks and cages</li> <li>• Efficiency and profitability of Nile tilapia (<i>Oreochromis niloticus</i>) and giant freshwater prawn (<i>Machrobrachium rosenbergii</i>) polyculture in pond-based biofloc system with refinements on feeding rates</li> <li>• Grow-out culture of abalone comparing the use of <i>Gracilariopsis heteroclada</i> and SEAFDEC formulated diet as feeds</li> <li>• Test of refined formulated feed for the grow-out culture of mangrove crab, <i>Scylla serrata</i> (Forsskal) in land-based tanks</li> <li>• Nutritional interventions to improve reproductive performance of Indian white prawn (<i>Penaeus indicus</i>)</li> </ul> |            |                |
| <p>3. Maintaining Environmental Integrity through Responsible Aquaculture (<i>ongoing</i>)</p> <p>The general objective of the Program is to develop environment-based aquaculture technology by integrating environmental factors in AQD research activities and maintain environmental integrity by promoting responsible aquaculture practices. In 2022, most of the studies undertaken in the previous year would be continued including:</p>  | AQD        | AQD*           |

| Program Title  | Department | Funding Source |
|--|------------|----------------|
| <ul style="list-style-type: none"> <li>• Enhancement of the technical skills to support community-based sea cucumber production in Philippines and Viet Nam</li> <li>• Development of optimal fish-prawn co-culture schemes in tanks and lake-based cages for increased farm production</li> <li>• Development of intermediate aquaculture system and advanced hatchery production to secure stable seed supply</li> <li>• Identification of tropical anguillid eels from selected natural habitats in the Philippines using environmental DNA assay</li> </ul>  |            |                |
| <p>4. Meeting Social and Economic Challenges in Aquaculture (<i>ongoing</i>)</p> <p>The Program generally aims to implement socioeconomic research and development studies to promote the inclusive engagement of fishing communities and small-holder fish farmers in aquaculture and resource enhancement. In 2022, the activities would include:</p> <ul style="list-style-type: none"> <li>• Assessment and development of community-based sandfish (<i>Holothuria scabra</i>) farming livelihood for fishing communities</li> </ul>   | AQD        | AQD*           |
| <p>5. Adapting to Climate Change Impacts (<i>ongoing</i>)</p> <p>The overall goal of the Program is to help ensure the sustainability of aquaculture amidst the expected impacts of disturbances on the aquaculture environment brought about by climate change/global warming. In 2022, the Program would continue to incorporate climate change-resilient practices in studies conducted by AQD as well as in training and information materials.</p>  | AQD        | AQD*           |
| <p>6. Collaborative projects with the Philippine Government (<i>ongoing</i>)</p> <p>With the goal of accelerating fish production and export revenues from the aquaculture sector in the Philippines, AQD is committed to intensifying the techno-transfer of matured aquaculture technologies to stakeholders which will provide additional and alternative livelihood to fishers through sustainable aquaculture technologies that are economically viable, environment-friendly, and socially equitable. In 2022, 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:</p> <ul style="list-style-type: none"> <li>• Fry sufficiency program</li> <li>• Development of cost-efficient feeds</li> <li>• Oplan Balik Sugpo (Operation Black Tiger Prawn Revival)</li> <li>• Accelerated Techno-transfer</li> <li>• Human resource development</li> </ul> | AQD        | AQD*           |

| Program Title   | Department | Funding Source |
|---|------------|----------------|
| <p>7. Promotion on Strengthening of SEAFDEC Visibility and Enhancing Human Capacity Building (<i>ongoing</i>)</p> <p>The Program has the overall objective of strengthening the visibility and image of SEAFDEC, while also enhancing the knowledge of relevant agencies and stakeholders on fisheries-related issues. In 2022, the activities would be categorized into 1) Promotion and enhancement of SEAFDEC visibility and image; 2) Production of information materials, <i>e.g.</i> books, brochures, videos, and other media, to promote awareness and understanding of fishers, stakeholders, and the public; 3) Management of information system including databases, TD website, and official social media; and 4) Enhancing the capacity of human resources including the conduct of tailor-made training based on the needs of partners and donors.</p>  | TD         | TD*            |
| <p>8. Improvement of Fisheries Technology and Reduction of the Impact from Fishing Activities (<i>ongoing</i>)</p> <p>The Program has the overall objective of improving fishing technologies and marine engineering to support the sustainable utilization of marine fishery resources. In 2022, the activities would be under three categories, namely: 1) Promotion of appropriate technologies and practices of fishing and marine engineering; 2) Study on the impacts on fisheries resources, marine environmental, social well-being, and livelihood from fishing activities; and 3) Database for fisheries management.</p>  | TD         | TD*            |
| <p>9. SEAFDEC Capacity Development through USAID Sustainable Fish Asia Activity (2020–2022)</p> <p>The project “Sustainable Fish Asia (SUFIA)” aims to improve the management of marine biodiversity and fisheries 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 landscape assessment (PSLA) to identify opportunities for collaboration with the private sector within the fishery industry in the region. Capacity development activities under task 1 will continue in 2022.</p> | TD         | USAID          |

\* Funding from regular contributions of respective Host Governments

### 3) Other Programs

| Program Title  | Department | Funding Source |
|--|------------|----------------|
| <p>1. Implementing the Lower Mekong Fish Passage Initiative in Cambodia, Thailand, and Viet Nam (2018–2020, extended to 2022)</p> <p>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. The Project was extended to 2021, for the construction of three additional demonstration fish passes in Cambodia. However, as activities in Cambodia in 2021 were delayed due to COVID-19, the Project was extended until September 2022 to complete the remaining activities.</p>  | TD         | US-DOI         |
| <p>2. Gender Dimension in the Value Chain of Small-scale Fisheries &amp; Aquaculture in Southeast Asia (2020–2021, extended to 2022)</p> <p>Implemented in four participating countries, namely: Lao PDR, Myanmar, Philippines, and Thailand, the Project has the 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. While the activities in 2020–2021 were completed in Thailand, Lao PDR, and Myanmar, the activities in the Philippines were delayed due to the COVID-19 situation; thus, the Project was extended until 2022. 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.</p> | TD         | FAO            |
| <p>3. Strategic Action Programme for the South China Sea and Gulf of Thailand (2018–2023)</p> <p>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 the implementation of the National Action Plans in support of the SAP, and strengthening regional</p>  | TD         | UNEP/GEF       |

| Program Title   | Department | Funding Source |
|---|------------|----------------|
| coordination for SCS SAP implementation. While UNOPS is responsible for national contracts, staff, and consultants, SEAFDEC is responsible for the Project office, regional contracts, meetings, training, and conferences.   |            |                |
| 4. Seminar-Workshop on Aquaculture Development in Southeast Asia (ADSEA) (2022)<br><br>The Seminar-Workshop on Aquaculture Development in Southeast Asia (ADSEA) which was proposed to be conducted by AQD in 2021 was postponed to 2022 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 and JTF    |

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

| Project Title  | Lead Department | Potential Donors |
|--|-----------------|------------------|
| 1. Promoting the Blue Economy and Strengthening Fisheries Governance of the Gulf of Thailand through the Ecosystem Approach to Fisheries (GoTFish Project) | TD              | FAO/GEF          |
| 2. Blue Horizon: Ocean Relief through Seaweed Aquaculture*   | SEC/AQD         | WWF-US/GEF       |
| 3. Implementation and Assessment of the ASEAN Regional Plan of Action for the Management of Fishing Capacity   | MFRDMD          | JAIF             |
| 4. Regional Technical Consultation on Aquatic Animal Health Emergencies in Southeast Asia*   | AQD             | JAIF             |
| 5. USAID Public International Organization (PIO) Grant Contribution to Southeast Asian Fisheries Development Center (SEAFDEC)*                             | TD              | USAID            |

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

## COOPERATION WITH DONORS AND OTHER ORGANIZATIONS IN 2021

### 1. Collaboration 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 a technical arm to implement fisheries programs/projects for the benefit of the ASEAN Member States (AMSs). In 2021, SEAFDEC 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 2030 (RES&POA-2030)” which was adopted by the ASEAN–SEAFDEC Ministers and Senior Officials in 2020. In 2021, 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-fourth Meeting of the FCG/ASSP organized on 24–25 November 2021 through the online platform.

In 2021, SEAFDEC was also represented in a number of events organized by the ASEAN, namely:

- 3<sup>rd</sup> ASEAN Meeting on Combating IUU Fishing in Partnership with the EU (23–24 February 2021, virtual meeting)
- 16<sup>th</sup> Meeting of the ASEAN Working Group on the Convention on International Trade in Endangered Species of Wild Fauna and Flora and Wildlife Enforcement (AWG-CITES and WE) (27 May 2021, virtual meeting)
- 11<sup>th</sup> Meeting of ASEAN Shrimp Alliance (ASA) (21 June 2021, virtual meeting)
- 13<sup>th</sup> Meeting of the ASEAN Fisheries Consultative Forum (AFCF) (22 June 2021, virtual meeting)
- 29<sup>th</sup> Meeting of the ASEAN Sectoral Working Group on Fisheries (ASWGF) (23–24 June 2021, virtual meeting)

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

On 2 April 2021, SEAFDEC signed with FAO the “Letter of Agreement (LOA) between FAO and SEAFDEC for provision of ‘Survey to Estimate Levels of Abandoned, Lost or Otherwise Discarded Fishing Gear in Thailand, Gillnet and Trap Fisheries.’” Under this LOA, FAO would provide funds to TD for the implementation of activities, *i.e.* 1) Provide recommendations for improvement of the FAO Fishing Gear Loss Questionnaires and associated User’s Manuals designed for gillnet and trap fisheries, 2) conduct a survey on ALDFG focusing on gillnets and traps at sites in Thailand using FAO Fishing Gear Loss Questionnaire, 3) Entering data into online FAO Fishing Gear Loss Questionnaire, 4) Participate in an online meeting organized by FAO to assess the results from the survey, and 5) Use the results from the workshop to produce the national report on gillnet and trap loss for Thailand.

The duration of the LOA was from 2 April 2021 to 30 November 2021. However, as the imposed COVID-19 movement restrictions created delays in the conduct of activities, an amendment to this LOA was signed on 18 December 2021 to extend this LOA, and the new termination date is on 31 January 2022.

On 9 April 2021, SEAFDEC signed with FAO the “Amendment to the LOA between FAO and SEAFDEC for ‘Provision of Gender Dimension in the Value Chain of Small- scale Fisheries and Aquaculture in Southeast Asia.’” The original “LOA between FAO and SEAFDEC for ‘Provision of Gender Dimension in the Value Chain of Small-scale Fisheries and Aquaculture in Southeast Asia’” was signed in February 2020 for FAO to provide funds to TD to implement the project entitled “Gender Dimension in the Value Chain of Small-scale Fisheries and Aquaculture in Southeast Asia” in four countries with the aim of enhancing the capacity of the countries’ staff involved in fisheries management and development programs and projects to enable them to integrate gender aspects in the program/project cycle. The original duration of this Project was from 1 January 2020 to 30 June 2021; however, it was anticipated that the activities could not be completed within the timeline due to the COVID-2019 situation. The amendment was, therefore, made to this LOA to extend the period until 30 June 2022.

On 20 April 2021, TD signed with FAO the “Letter of Agreement (LOA) between FAO and SEAFDEC for the provision of ‘An assessment of the sustainability of currently used fishing technologies and operations in Thailand and options for innovation and improvements.’” Under this LOA, FAO would provide funds to TD for the implementation of activities, *i.e.* 1) Carry out desk review on currently used fishing technologies and operations in Thailand and prepare a draft assessment report including options for innovation improvement; 2) Organize stakeholders meeting to discuss and agree on fisheries innovation options in Thailand, including cost and benefit, and social, economic and environmental returns; 3) Prepare and submit to FAO the final assessment report on the sustainability of fishing technologies and operations in Thailand and options for innovation and improvement; and 4) Share outcomes with other stakeholders, and prepare final project report. The duration of the original LOA was from 9 April 2021 until 15 September 2021. However, as the conduct of activities was delayed due to the COVID-19 movement restrictions, the extension of this LOA was made through the signing of the Amendment to the LOA on 10 September 2021, and the new termination date of the LOA was on 15 December 2021.

On 9 December 2021, SEAFDEC signed the “Letter of Agreement (LOA) between FAO and SEAFDEC for provision of ‘Collection of Research and Datasets from data-poor countries in Southeast Asia related to SDG Indicator 14.4.1 and formulation of a Thesaurus for Aquatic Genetic Resources.’” Under this LOA, FAO would provide funds to SEAFDEC for the implementation of activities, *i.e.* 1) Definition of subject scope and search strategy for identifying research and data related to SDG Indicator 14.4.1 agreed and documented; 2) A series of five online training sessions to be held with participants, enabling them to deploy the above search strategy and record research and data related to SDG Indicator 14.4.1; 3) Research and data recorded by participants will undergo bibliometric analysis with results presented in a report, and 4) Terminology proposed by Aquatic Genetic Resources to undergo review by SEAFDEC/AQD resulting in a thesaurus of roughly 100 terms that can be used in the Aquatic Genetic Resources registry and other systems. The LOA entered into force from 1 January 2022 until 30 November 2022.

Moreover, SEAFDEC in 2021 cooperated with FAO to implement two regional projects with support from the Global Environmental Facility (GEF). The first project was “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” (BOBLME Phase II) which would be implemented from 2022 to 2026 with the overall objective to contribute to sustainable management of fisheries, marine living resources and their habitats in the Bay of Bengal region for the benefit of coastal states and communities. The Project would be implemented by SEAFDEC together with other organizations, *i.e.* IUCN and BOBP-IGO, in participating countries, namely: Bangladesh, India, Indonesia, Malaysia, Maldives, Sri Lanka, Thailand. Another project was “Promoting the Blue Economy and Strengthening Fisheries Governance of the Gulf of Thailand through the Ecosystem Approach to Fisheries” (GoTFish Project). The Project is in the process of developing the Project Preparation Grant (PPG).

In 2021, SEAFDEC was also 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:

- 34<sup>th</sup> Session of FAO Committee on Fisheries (organized by FAO on 1–5 February 2021, virtual meeting)
- Webinar on Review of Illegal Fishing in the APFIC Region (organized by FAO/APFIC on 10 February 2021, Webinar)
- Webinar on Antimicrobial Resistance (AMR) and Antimicrobial Use (AMU) in Aquaculture in Asia (organized by FAO/APFIC on 24 February 2021, online meeting)
- Webinar on Multispecies Stock Assessment for Management (organized by FAO/APFIC on 10 March 2021, online meeting)
- Webinar on Aquaculture Innovation in the APFIC Region (organized by FAO/APFIC on 25 March 2021, online meeting)
- Webinar on Subsidies, WTO and Fisheries (organized by FAO/APFIC on 31 March 2021, online meeting)
- Webinar on Information Technology for Small-scale Fisheries (organized by FAO/APFIC on 6 April 2021, online meeting)
- Webinar on Co-management of Small-scale Fisheries (organized by FAO/APFIC on 8 April 2021, online meeting)
- 36<sup>th</sup> Session of the Asia-Pacific Fishery Commission (APFIC) (organized by FAO/APFIC on 5–7 May 2021, online meeting)
- 3<sup>rd</sup> Meeting to the Parties to the 2009 FAO Agreement on Port State Measures (organized by FAO on 31 May–4 June 2021, online meeting)
- GEF Project Preparation Grant (PPG) Inception Workshop of the Project “Promoting the Blue Economy and Strengthening Fisheries Governance of the Gulf of Thailand through the Ecosystem Approach to Fisheries” (GoTFish Project) (organized by FAO and SEAFDEC on 8 September 2021, online meeting)
- Global Conference on Aquaculture Millennium +20 (organized by FAO/NACA/MARA on 23–24 September 2021, Shanghai, China)
- FIRMS Technical Working Group Meeting on the Global Record of Stocks and Fisheries (organized by FAO/FIRMS on 30 September & 1 October 2021, online meeting)
- 12<sup>th</sup> Session of the FIRMS Steering Committee (organized by FAO/FIRMS on 18–21 October 2021, online meeting)



- Intersessional Meetings of the Coordination Working Parties on Fishery Statistics (CWP) (organized by FAO/CWP on 2–5 November 2021, online meeting)
- APFIC Webinar Series: Women and men in small-scale fisheries and aquaculture in Asia: barriers, constraints and opportunities towards equality and secure livelihoods (organized by FAO/APFIC on 7 December 2021, online meeting)

In 2021, FAO also extended the expertise of resource persons in several events organized by SEAFDEC, including, among others the expertise of:

- *Ms. Stefania Vannuccini* during the 1<sup>st</sup> Regional Technical Consultation on Fishery Statistics and Information in Southeast Asia (organized by SEAFDEC Secretariat on 21–22 September 2021, online meeting)
- *Dr. Rishi Sharma* during the Consultative Planning and Training Workshop on Stock Assessment in Support the Implementation of the International Commitments for Sustainable Use of Fisheries Resources in Southeast Asia (organized by SEAFDEC Secretariat on 9 and 13–17 December 2021, in Bangkok, Thailand and online meeting)

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

Under the framework of the “Memorandum of Understanding” between SEAFDEC and the Intergovernmental Organization for Marketing Information and Technical Advisory Services for Fishery Products in the Asia and Pacific Region (INFOFISH) signed in 2020, SEAFDEC continued to cooperate with INFOFISH in the exchange of information and expertise. In 2021, SEAFDEC was requested by the INFOFISH to provide online training on fish handling and onboard fish handling for INFOFISH member countries. In response, the course curriculum was developed for consideration by INFOFISH.

In 2021, SEAFDEC also invited the representatives from INFOFISH to share their experiences as resource speakers in events, including among others:

- *Ms. Shirlene Marine Anthonysamy* during the SEAFDEC Webinar Series: Regional Responses to U.S. Marine Mammal Protection Act (organized by SEAFDEC Secretariat on 2–3 November 2021, online meeting)

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

In 2021, 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 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 was extended until 2022.

In 2021, SEAFDEC also continued to implement the project “Development of Stock Assessment Method and Strengthening of Resources Management Measures on Tropical Anguillid Eels in ASEAN Region” supported by the JAIF 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 which was originally scheduled to complete in 2021 was also extended until 2022.

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

Since 2016, SEAFDEC has served as the implementing agency of 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 focused 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, which was originally from March 2016 to December 2020, was extended with technical closure by 31 December 2022, and financial closure by 30 June 2023.

Another project supported by GEF through UNEP was the “Strategic Action Programme for the South China Sea,” with the PCA 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 the national contracts, staff, and consultants, SEAFDEC is responsible for the Project office, regional contracts, meetings, training, and conferences. The duration of the Project is from 2018 until June 2023.

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

In 2021, the United States Agency for International Development Regional Development Mission for Asia (USAID/RDMA) launched the two-year project “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 the private sector within the fisheries industry in the region. In 2021, SEAFDEC also received a sub-award from RTI with the purpose to implement capacity development activities to enhance the capacities of SEAFDEC for compliance with USAID’s requirements as a public international organization (PIO).

Under the framework of cooperation with the USAID, SEAFDEC also availed of support from resource persons from U.S. National Oceanic and Atmospheric Administration at the events organized by SEAFDEC:

- *Dr. Christopher Rogers* during the SEAFDEC Webinar Series: Regional Responses to U.S. Marine Mammal Protection Act (organized by SEAFDEC Secretariat on 2–3 November 2021, online meeting)
- *Dr. Nina Young* during the SEAFDEC Webinar Series: Regional Responses to U.S. Marine Mammal Protection Act (organized by SEAFDEC Secretariat on 2–3 November 2021, online meeting)

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

In 2021, SEAFDEC continued to provide support to the design and construction of one fish passage each in Cambodia, Thailand, and Viet Nam under “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” which was signed in July 2018. The specific objectives of this Annex 2 were 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. This Annex 2 was originally scheduled to be completed in 2020 but was amended in February 2020 to extend it until 30 September 2021. In addition, Amendment 2 to Annex 2 was signed in November 2020 to include “Design and Construct Three (3) Additional Demonstration Fish Passes in Cambodia,” which was also scheduled to be completed on 30 September 2021. However, with the delay of activities due to the COVID-19 situation, Amendment 3 to Annex 2 was signed on 15 October 2021 to extend Annex 2 until 30 September 2022.

## 2. Cooperation with National Agencies of SEAFDEC Member Countries

- **University of Palangka Raya, Indonesia**

On 8 December 2021, SEAFDEC/IFRDMD signed the “Agreement Concerning Enhancing Sustainability of Peatland Area Through Freshwater Aquaculture and Community Engagement Strategies between University of Palangka Raya and SEAFDEC/IFRDMD.” The field of cooperation under this Agreement concerns all common mutual interests and commits to develop education for environmental conservation, sustainable inland water resources management research, as well as community fisheries development. The specific objectives of the Agreement including 1) to collaborate by facilitating the exchange of educator/trainer, students, ideas, and opportunities upon visit or research or other instructional capacities, within continuous period as determined in specific program; 2) to disseminate information on teaching, research programs, and innovations available at both Parties; 3) to constitute research teams on subjects of common interest based on the important needs of both parties; 4) to help in welcoming part-time students and interns, short courses, where appropriate programs may exist now and in the future; the student exchange programs, which will be organized and managed by the faculties and/or Banyan Tree in the framework of particular agreements; and 5) to encourage mutual participation in scientific events such as conferences, seminars and seasonal schools which may be organized by one of the Party. This Agreement is valid for four years starting from the signing date.

- **Faculty of Fishery and Marine Science, Riau University, Indonesia**

On 16 December 2021, SEAFDEC/IFRDMD signed the “Agreement Concerning Enhancing Education Program for Environmental Conservation, Sustainable Inland Water Resources Management Research as well as the Community Fisheries Development Activities between Faculty of Fisheries and Marine Science, Riau University and SEAFDEC/IFRDMD.” The field of cooperation under this Agreement concerns all common mutual interests and commits

to develop education for environmental conservation, sustainable inland water resources management research, as well as community fisheries development. The Agreement has specific objectives: 1) to collaborate by facilitating the exchange of educator/trainer, students, ideas, and opportunities upon visit or research or other instructional capacities, within continuous period as determined in specific program; 2) to disseminate information on teaching, research programs, and innovations available at both Parties; 3) to constitute research teams on subjects of common interest based on the important needs of both parties; 4) to help in welcoming part-time students and interns, short courses, where appropriate programs may exist now and in the future; the student exchange programs, which will be organized and managed by the faculties and/or Banyan Tree in the framework of particular agreements; and 5) to encourage mutual participation in scientific events such as conferences, seminars and seasonal schools which may be organized by one of the Party. This Agreement is valid for four years starting from the signing date.

- **Hokkaido University, Japan**

On 3 February 2021, SEAFDEC signed the “Extension of the Arrangement for Scientific, Educational, and Technical Cooperation between SEAFDEC and the Faculty of Fisheries Sciences, Hokkaido University of Japan (FFS-HU), Japan.” The “Arrangement for Scientific, Educational, and Technical Cooperation between SEAFDEC and the FFS-HU” was first signed in February 2006 for cooperation toward the sustainable development of fisheries; and was extended in 2011 and 2016. Considering that the Arrangement between FFS-HU and SEAFDEC has expired in 2021, another Extension of the Arrangement was signed in February 2021 to extend the Arrangement for five more years.

- **Gifu Prefecture, Japan**

On 6 July 2021, SEAFDEC signed the “Extension of the Memorandum of Understanding (MOU) between Gifu Prefecture and SEAFDEC.” The MOU between Gifu Prefecture and SEAFDEC was first signed on 27 May 2016 with the aim of promoting educational and technical cooperation for the sustainable development of inland fisheries in the Southeast Asian region, and the original MOU was effective for five years until 26 May 2021. In order to continue the cooperation between Gifu Prefecture and SEAFDEC, an extension to this MOU was therefore signed, and such extension was executed from 6 July 2021 for five more years.

- **Local Government Unit of Barangay Pipindan (Pipindan LGU) and Pipindan Aquaculture Producers Association (PAPA), Philippines**

On 10 March 2022, SEAFDEC/AQD signed the “Memorandum of Agreement (MOA) among SEAFDEC/AQD, the ‘Local Government Unit of Barangay Pipindan (Pipindan LGU),’ and the ‘Pipindan Aquaculture Producers Association (PAPA).’” This MOA covers the project “Community-Based Sustainable Aquaculture Livelihood (CBSAL)” which generally aims to develop community-based strategies for the production of high-value indigenous species such as giant freshwater prawn through the hatchery and nursery of post-larvae for grow-out and for cash crop to contribute towards securing food and livelihood of the members of PAPA and for the benefit of the community in Barangay Pipindan. This MOA is effective from the signing date until 31 December 2024.

- **Mindanao Development Authority (MinDA), Philippines**

On 6 September 2021 SEAFDEC/AQD signed the “Memorandum of Agreement between Mindanao Development Authority (MinDA) and SEAFDEC/AQD.” The objective of the MOA is for the parties to collaborate in the area of sustainable aquaculture through the techno-transfer program including verification and training in broodstock, hatchery, nursery, and grow-out operations of commercially viable finfishes, crustaceans, mollusks, and seaweeds. Under the MOA, AQD will provide technical assistance to MinDA and/or the identified stakeholders of the aquaculture industry through an extension program; undertake a techno-transfer program; and conduct and implement the project in accordance with the approved project proposal. The MOA is effective from the signing date for the period of three years.

- **Panay Aquafarmers Consumers Cooperative (PAFCC), Philippines**

On 24 September 2021, SEAFDEC/AQD signed the “Memorandum of Agreement (MOA) between Panay Aquafarmers Consumers Cooperative (PAFCC) and SEAFDEC/AQD.” The purpose of this MOA is for the parties to collaborate on putting up and operating a Feed Mill Plant in Capiz to reduce aquaculture production costs and benefit the fish farmers in Western Visayas and other nearby areas. Under this MOA, the PAFCC will provide funds to AQD for the conduct and preparation of a feasibility study, project proposal, and related documents, and assistance during the proposal development and preparation phase for the project “Establishing and Aquaculture Feed Mill Plant and Operating the Said Plant in the Province of Capiz.” The MOA is effective from the signing date until January 2024.

- **Department of Marine and Coastal Resources (DMCR), Thailand**

On 31 May 2021, SEAFDEC signed the “Memorandum of Understanding (MOU) between the Department of Marine and Coastal Resources (DMCR) of Thailand and SEAFDEC.” The objectives of the MOU that the DMCR and SEAFDEC/TD to cooperate in 1) conducting research and technical development on fishing gears that result in impacts on marine and coastal resources, as well as on distribution and impacts from marine litter and microplastics; 2) exchanging knowledge on classification of marine litters from fishing activities; 3) conducting research on marine litters and microplastics distribution in the sea and endangered and threatened species; and 4) research and development on fishing gears to mitigate their impacts on endangered and threatened species. The scopes of the cooperation cover the operation, exchange of knowledge, experiences, and technical information, as well as provision of technical advice or cooperation in other relevant activities. The MOU is valid for five years starting from the signing date.

## **PROGRESS IN THE IMPLEMENTATION OF INFORMATION STRATEGIES FOR ENHANCING SEAFDEC VISIBILITY AND COMMUNICATION IN 2021**

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 fully made 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 2021, the progress and achievements made by SEAFDEC in the implementation of the Information Strategies were monitored and discussed during the 22<sup>nd</sup> Meeting of the Information Staff Program (ISP) on 29 November and 1 December 2021 through the online meeting and were subsequently updated to cover the period from 1 January to 31 December 2021. Summary of the progress corresponding to the five Information Strategies are as follows:

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

- Technical/scientific materials: 49 title/issues produced: 4,574 copies published, with 2,203 hard-copies and 4,387 e-copy distributed
- Technical videos: 77 titles produced, with 4,753 online views
- Technical/scientific articles: 129 titles produced: 32 titles published in SEAFDEC publications and 97 titles published in non-SEAFDEC publications
- Inquiries for information through the SEAFDEC libraries recorded and replied: 4,898 queries recorded (including 77 from the e-mail, 1,213 from social media, 610 from the website, 1,967 from the repository, and 1,033 from the library), 664 materials sold, and 20,060 citations
- Number of citations: 24,537 citations (including 24,037 citations from Scopus, and 736 citations from Google Scholar)

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

- Promotional materials: 24 titles/issues produced: 19,378 copies published, with 15,818 hard-copies and 11,010 e-copies distributed
- Promotional souvenirs: 454 items produced, and 253 items distributed
- Promotion videos: 4 titles produced, and 55,720 online views
- SEAFDEC websites established: SEAFDEC Departmental websites had a total of 109,571 unique visitors, and 6,550 links from other websites
- Project websites: 3,879 unique visitors, and 21 links from other websites
- Social media administered by SEAFDEC: 38,990 followers, 1880,701 likes, and 3,093,685 reaches

- Participation in exhibitions and related events: joined 3 exhibitions with 78 visitors recorded at SEAFDEC exhibition booths and displays
- Official press statements released: twenty-one (21) press statements were released, and recorded 129 appearances of SEAFDEC in public media and on websites
- Consolidated views of the respective countries on the current WTO Draft Consolidated Text on Fisheries Subsidies Negotiation were agreed upon at the Webinar Series on WTO Fisheries Subsidies Draft Consolidated Text on 17 June 2021

**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: a total of 368 issues of newsletters/serial publications, 140 titles of technical publications, and one (1) audio-visual material were acquired
- Cooperation and exchange of materials: sustained cooperation with 388 network libraries within and outside the region
- Dissemination of technical and promotional materials: 72 titles (with 6,150 copies) of technical materials, and 32 titles (with 15,471 copies) of promotional materials disseminated to target groups
- Accessibility of information materials: 7,073 downloadable materials, 620,044 downloads during the reporting year, and 5 databases made accessible on SEAFDEC websites
- Institutional Repository: 3,916,215 unique visitors; 1,528 titles of materials uploaded during the reporting year, 9,272 accumulated titles, and 622,971 downloads during the reporting year
- Usage of e-mail systems (including e-groups) to facilitate communications both among SEAFDEC staff and with other concerned personalities had been enhanced
- Direct visitors to SEAFDEC Secretariat and Departments: recorded a total number of 116 visitors (*the number of visitors in 2021 decreased due to the COVID-19 situation*)
- Participation of SEAFDEC officials in events organized by other organizations: 399 SEAFDEC officials participated in 151 events: 234 officials at regional/international levels (*83 in virtual events*), and 165 officials at national/local levels (*11 in physical events and 57 in virtual events*)
- Number of presentations made by SEAFDEC Staff at non-SEAFDEC events: 9 oral presentations in events at regional/international levels; and 20 oral presentations and 4 posters presented in events at national/local levels
- SEAFDEC events organized:
  - o International/regional meetings, seminars, workshops: 15 meetings with 815 participants (*all are virtual meetings*)
  - o National/local meetings, seminars, workshops, consultations: 10 meetings with 916 participants (*4 physical events with 74 participants, and 6 virtual events with 842 participants*)
  - o International/regional training courses: 17 courses with 488 trainees (*all are online training courses*)

- o National, on-site training courses: 20 courses with 356 trainees (*5 physical training courses with 149 trainees, and 15 online training courses with 207 trainees*)
- o Study tours: no study tours during reporting year due to the COVID-19 situation
- o Internships: 2 groups with 4 interns
- o On-the-job training: 1 college participated with a total of 134 students
- o Internal meetings: 10 meetings with 353 participants (*1 physical meeting with 10 participants, and 9 virtual meetings with 343 participants*)
- Participation of officials from Member Countries in events organized by SEAFDEC:
  - o International/regional meetings, seminars, workshops (470 participants)
  - o National/local meetings, seminars, workshops, consultations (187 participants)
  - o International/regional training courses (372 trainees)
  - o National on-site training courses (339 trainees)
  - o Study tours (*no study tours during reporting year due to the COVID-19 situation*)
  - o Internships (4 persons)
  - o On-the-Job training (134 students)
- Network and cooperation mechanisms established (now with 44 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 2021: USD 6,734,208 representing non-regular sources of funds for the activities of SEAFDEC (*USD 2,559,615 from agencies/institutions in the region and USD 4,174,593 from agencies/institutions outside the region*)

#### **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 the intensified sale of technical publications and souvenir items on a 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-second Meeting of the SEAFDEC Information Staff Program (ISP) organized to monitor the implementation of information-related activities, in accordance with the Information Strategies for Enhance SEAFDEC Visibility and Communication (convened on 29 November and 1 December 2021 through Online Meeting)



**Table 1.** Participation of Member Countries in SEAFDEC Events in 2021

| 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        | 28   | 30        | 124        | 15        | 14        | 45        | 32        | 81          | 16        | 44         | 41         |
| SEAFDEC national/local meetings, seminars, workshops, consultations | 0  | 18        | 0          | 0         | 36        | 8         | 0         | 0           | 0         | 125        | 0          |
| International/regional training courses                             | 19   | 22        | 76         | 1         | 9         | 29        | 21        | 106         | 5         | 40         | 44         |
| National, on-site training courses (course/trainees)                | 8  | 0         | 0          | 0         | 0         | 17        | 26        | 140         | 0         | 128        | 20         |
| Study tours (no. of program/trainees)                               | 0  | 0         | 0          | 0         | 0         | 0         | 0         | 0           | 0         | 0          | 0          |
| Internships (group/persons)   | 0  | 0         | 0          | 0         | 0         | 0         | 0         | 0           | 0         | 4          | 0          |
| On-the-job training (college/students)                              | 0  | 0         | 0          | 0         | 0         | 0         | 0         | 134         | 0         | 0          | 0          |
| SEAFDEC internal events   | 0  | 0         | 0          | 0         | 0         | 0         | 0         | 34          | 0         | 0          | 0          |
| <b>TOTAL</b>  | <b>55</b>                                    | <b>70</b> | <b>230</b> | <b>16</b> | <b>59</b> | <b>99</b> | <b>79</b> | <b>495</b>  | <b>21</b> | <b>341</b> | <b>105</b> |

## PROGRESS IN THE IMPLEMENTATION OF SEAFDEC GENDER STRATEGY IN 2021

The SEAFDEC Gender Strategy was approved by the 51<sup>st</sup> Meeting of the SEAFDEC Council in 2019 for implementation by the SEAFDEC Secretariat and Departments with the goal of “SEAFDEC as 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 2021 could be summarized as follows:

### Strategy 1: Mainstreaming gender at all levels of the organization

- Policies and regulations for the staff: generally applied equally to females and males, 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, Muslim prayer room for men/women
- Number of staff in the HR system: a total of 525 staff (212 females and 313 males) at the SEAFDEC Secretariat and five Departments
- SEAFDEC staff participated in seven (7) events of gender-related training organized by other organizations

### Strategy 2: Integrating gender in SEAFDEC programs and projects

- Gender-sensitive<sup>1</sup> programs/projects: 7 regional projects (out of 16) are gender-sensitive
- Stakeholders and participants involved in programs/projects of SEAFDEC: 2,138 stakeholders/ participants (527 females and 791 males) involved
- Gender-related events organized by SEAFDEC: 3 events, with a total of 82 participants (53 females and 29 males) attended

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

- Equal opportunities given for the participation of male and female representatives in all events organized by SEAFDEC
- Sex disaggregated number of participants in events organized by SEAFDEC:
  - o Regional/international meetings, seminars, workshops: 15 events, with 815 participants (369 females and 446 males)
  - o SEAFDEC national/local meetings, seminars, workshops, consultations, etc.: 10 events, with 916 participants (122 females and 133 males)
  - o International/ regional training courses: 17 events, with 488 participants (182 females and 306 males)
  - o National, on-site training courses: 20 events, with 356 participants (176 females and 180 males)

<sup>1</sup> 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.



- o Study tours: none
- o Internships (group/persons): 2 events, with 4 participants (1 female and 3 males)
- o On-the-job training (students): 1 event, with 134 participants (76 females and 58 males)
- o SEAFDEC Internal Events: 10 events, with 379 participants (147 females and 132 males)

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

- Articles/papers/reports published and distributed: 3 titles, with 1,600 hard copies produced, 1,400 hard copies distributed, and 476 e-copies downloaded
- Presentation on the gender-related subjects at events organized by other organizations: four (4) oral presentations

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

- Collaboration with four (4) organizations by participating in the events, and providing inputs during the session.

## SEAFDEC REVENUES AND EXPENDITURES IN 2021

### Un-Audited Abridged Consolidated Financial Statements As at December 31, 2021 and 2020 (in US\$)

|   | 2021<br>(Un-audited)     | 2020<br>(Audited)               |
|---|--------------------------|---------------------------------|
| <b>REVENUES</b>                                 |                          |                                 |
| Contributions from:                             |                          |                                 |
| Member governments                              | 10,813,393               | 11,321,346                      |
| Other sources                                   | 195,614                  | 739,862                         |
| Other income                                    | 946,568                  | 559,447                         |
| <b>Total Revenues</b>                           | <b>11,955,575</b>        | <b>12,620,655</b>               |
| <b>EXPENDITURES</b>                             |                          |                                 |
| Operating and Capital Expenditures              |                          |                                 |
| Research  | 3,687,229                | 3,926,091                       |
| Training  | 702,987                  | 1,148,241                       |
| Information                                     | 473,161                  | 554,779                         |
| Collaborative                                   | 114,541                  | 131,709                         |
| Others  | 68,136                   | 297,510                         |
| Administrative                                  | 3,908,454                | 4,573,747                       |
| <b>Total Expenditures</b>                       | <b>8,954,508</b>         | <b>10,632,077</b>               |
| SURPLUS (DEFICIT), For the year                 | 3,001,067                | 1,988,578                       |
| FUND BALANCE, Beginning of year                 | 15,935,814 <sup>1/</sup> | 15,191,064                      |
| FUND ADJUSTMENT                                 | (260,446)                | (12,948)                        |
| <b>FUND BALANCE, End of year</b>                | <b>18,676,435</b>        | <b>17,166,694</b> <sup>1/</sup> |
| <b>REPRESENTED BY:</b>                          |                          |                                 |
| <b>ASSETS</b>                                   |                          |                                 |
| <b>Current assets</b>                           |                          |                                 |
| Cash and cash equivalents                       | 18,668,120               | 17,811,997                      |
| Receivables and other receivables               | 501,116                  | 393,106                         |
| Advance and deposits                            | 111,134                  | 58,432                          |
| Materials and supplies inventory                | 56,640                   | 35,835                          |
| Fuel oil for vessels                            | 142,966                  | 177,960                         |
| Prepayments                                     | 193,793                  | 6,515                           |
| Other Current assets                            | 2,168                    | 2,028                           |
| <b>Total Current assets</b>                     | <b>19,675,937</b>        | <b>18,485,873</b>               |
| <b>Noncurrent assets</b>                        |                          |                                 |
| Reserved budget for vessel periodic maintenance | 337,840                  | 301,466                         |
| Termination indemnity fund                      | 2,235,012                | 2,474,403                       |
| Long-term investments                           | 454,005                  | 482,140                         |
| Other noncurrent assets                         | 350,397                  | 256,001                         |
| <b>Total Noncurrent Assets</b>                  | <b>3,377,254</b>         | <b>3,514,010</b>                |
| <b>TOTAL ASSETS</b>                             | <b>23,053,191</b>        | <b>21,999,883</b>               |
| <b>Less: Liabilities</b>                        |                          |                                 |
| Accrued payable                                 | 821,505                  | 977,237                         |
| Contribution received in advance                | 981,556                  | 1,139,750                       |
| Fund held in trust                              | 338,683                  | 241,799                         |
| <b>Total Current Liabilities</b>                | <b>2,141,744</b>         | <b>2,358,786</b>                |
| Provision for termination indemnity             | 2,235,012                | 2,474,403                       |
| <b>Total Liabilities</b>                        | <b>4,376,756</b>         | <b>4,833,189</b>                |
| <b>NET ASSETS</b>                               | <b>18,676,435</b>        | <b>17,166,694</b>               |

Remark: <sup>1/</sup> The Difference of US\$ 1,230,880 is a resulted of change of rate in US\$ translation.

### Un-audited Contribution Received by SEAFDEC from Member Countries and Other Sources for the Year 2021 (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            | 0.10          |
| Indonesia                   | 52,000         | -                | -    | -                | -              | 703,590        | 755,590           | 6.32          |
| Japan                       | 280,000        | -                | -    | -                | -              | -              | 280,000           | 2.34          |
| Lao PDR                     | 6,500          | -                | -    | -                | -              | -              | 6,500             | 0.05          |
| Malaysia                    | 21,500         | -                | -    | -                | 667,019        | -              | 688,519           | 5.76          |
| Myanmar                     | 22,500         | -                | -    | -                | -              | -              | 22,500            | 0.19          |
| Philippines                 | 25,000         | -                | -    | 6,078,550        | -              | -              | 6,103,550         | 51.05         |
| Singapore                   | 13,500         | -                | -    | -                | -              | -              | 13,500            | 0.11          |
| Thailand                    | 33,000         | 2,865,234        | -    | -                | -              | -              | 2,898,234         | 24.24         |
| Viet Nam                    | 26,000         | -                | -    | -                | -              | -              | 26,000            | 0.22          |
| <b>Sub-total</b>            | <b>499,000</b> | <b>2,865,234</b> |      | <b>6,078,550</b> | <b>667,019</b> | <b>703,590</b> | <b>10,813,393</b> | <b>90.44</b>  |
| Other Sources <sup>2/</sup> | 100,624        | 389,389          | -    | 652,169          | -              | -              | 1,142,182         | 9.56          |
| <b>Total</b>                | <b>599,624</b> | <b>3,254,623</b> |      | <b>6,730,719</b> | <b>667,019</b> | <b>703,590</b> | <b>11,955,575</b> | <b>100.00</b> |

**Remark:**

<sup>2/</sup> Other sources of contribution include bank interest, gain/loss from varying exchange rates, contribution from donor directly given to Departments and miscellaneous receipts.

### Un-audited Other Contributions Received by SEAFDEC in 2021 (in US\$)

| Sources  | Amount in US\$ <sup>3/</sup> |
|--|------------------------------|
| Japanese Trust Fund (excluded: Japan MRC = US\$ 280,000)   | 1,550,357                    |
| UNEP/GEF "Establishment and Operation of a Regional System of Fisheries <i>Refugia</i> in the South China Sea and Gulf of Thailand" (Fisheries <i>Refugia</i> Project) | 288,457                      |
| UNEP/GEF "Implementing the Strategic Action Programme for the South China Sea and Gulf of Thailand" (SCS/SAP Project)  | 608,400                      |
| <b>Total</b>   | <b>2,447,214</b>             |

**Remark:**

<sup>3/</sup> Other sources of contribution which are not reported in the SEAFDEC Financial Statements.