

SEAFDEC Annual Report 2022



Southeast Asian Fisheries Development Center

SEAFDEC Annual Report

2022



Southeast Asian Fisheries Development Center

Preparation and Distribution of this Document

This SEAFDEC Annual Report 2022 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.

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EXECUTIVE SUMMARY

The progress and achievements of SEAFDEC through the programs and activities undertaken from January to December 2022 were summarized in this SEAFDEC Annual Report 2022. 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 (19 projects); Departmental Programs (8 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 2022, 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 and aquaculture, specifically in availing of their expertise and relevant resources for the programs and activities that are of mutual interest.

It is the hope of SEAFDEC that the SEAFDEC Annual Report 2022 would serve as a reference for the 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 and aquaculture in the Southeast Asian region.

MESSAGE FROM THE CHAIRPERSON OF THE SEAFDEC COUNCIL



Throughout 2020 up to early 2022, the countries in Southeast Asia had been facing enormous challenges brought about by COVID-19. The fisheries sector had immensely been impacted by this situation necessitating mitigation measures to ensure that the fishing, aquaculture, fish trade, and livelihood activities of people could be maintained with minimum impacts. It is with my gladness that the situation all over the world has now improved and we are resuming a normal situation. I also join hands with other countries to congratulate SEAFDEC for maintaining its activities as far as these could be practical during the past three years

and for the effort in documenting the situation and its impacts through its dedicated study on the subject.

In 2022, while countries in the region continued to address important issues and challenges such as IUU fishing, the need to obtain information on the status of fishery resources (including those for inland), and sustaining the contribution from fisheries and aquaculture with high-quality and safe products; there were a number of significant developments that were envisaged to impact the fisheries sector, especially the trade-related requirements. The World Trade Organization (WTO) discussion on fisheries subsidies that had been prolonged for over a decade has recently been concluded with the final text of the Agreement on Fisheries Subsidies. Furthermore, one of the important fish-importing markets—the U.S.—is in the process of putting into practice its Marine Mammal Protection Act; while Japan—another important market—has recently put into practice Japan’s Catch Documentation Scheme. It is envisaged that countries in the region together with SEAFDEC would discuss and work closely together to see how we can best facilitate our fishery and aquaculture industries in fulfilling the emerging requirements in the most practical way.

As the activities of SEAFDEC that were restricted mainly as online events since 2020 had resumed with the conduct of physical and on-site activities during the second half of 2022, I, therefore, urge SEAFDEC to actively pursue the momentum of work in collaboration with the Member Countries as well as collaborating organizations in the upcoming year. One of the issues that need to be tackled in particular is the securing of sustainable small-scale fisheries and aquaculture. Although 2022 has already seen the celebration of the International Year of Artisanal Fisheries and Aquaculture, the momentum of activities toward improving the livelihood of people dependent on aquatic resources should be continued; and I congratulate SEAFDEC for being an organization that actively works on this aspect of activities for over a decade already.

In this opportunity, I would like to congratulate SEAFDEC once again for its efforts in undertaking activities that led toward the sustainable development of fisheries and aquaculture of the region, the progress of which had been summarized in this SEAFDEC Annual Report 2022. On behalf of the SEAFDEC Council, I would like to express our appreciation also to collaborating partners and donor agencies for extending their continued support and cooperation to SEAFDEC throughout the year. It is the aspiration of all Member Countries to see SEAFDEC continue to be an organization that endeavors a leading role in fostering cooperation in fisheries in the region in the coming years.



*Dato' Adnan bin Hussain
Director-General of Fisheries Malaysia
Department of Fisheries Malaysia*

MESSAGE FROM THE SEAFDEC SECRETARY-GENERAL



The year 2022 was a big transition for SEAFDEC as the COVID-19 situation that impacted the overall activities of SEAFDEC since 2020 has been finally alleviated. Despite the uncertain situation this year, SEAFDEC was able to support the Member Countries, particularly the ASEAN Member States (AMSs), in the implementation of the “Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2030.” This year, the activities continued to focus on research, technology development, and capacity building toward ensuring that fishery resources are utilized in a sustainable manner and contribute to the food security of people in the region and worldwide.

The issue of illegal, unreported and unregulated or IUU fishing was continued to be tackled by countries in the region, not only through tools and platforms facilitated by SEAFDEC but also by the other regional mechanisms including the under the ASEAN framework and the Regional Plan of Action to promote responsible fishing practices including combating IUU Fishing (RPOA-IUU). Cooperation among relevant agencies in this area is therefore expected to be strengthened in the coming year. In 2022, we also saw new advancements in several fish trade regulations that necessitated the countries in Southeast Asia to collaborate and support each other in exploring appropriate strategies and ensure that such trade-related measures create minimum impacts on the fishery sector of the region. The nature of the fisheries that are small-scale and comprise multispecies catch needs to be fully considered. In addition to enhancing the sustainability of capture fisheries and obtaining an understanding of the status of marine resources, activities on other sub-sectors including promotion of sustainable inland capture fisheries, improving post-harvest processing to ensure good quality and hygiene of fish and fishery products, developing and promoting responsible aquaculture technologies and practices, among others, were also under the focus of SEAFDEC. Moreover, the initiative to make full use of data and information to provide better knowledge of the fisheries situation of the region was also sustained with the production of the third in a series of the publication “Southeast Asian State of Fisheries and Aquaculture” or SEASOFIA 2022; we truly hope that this will serve as an important reference material for ranges of people not only in the region but also worldwide.

While supporting the Member Countries in the implementation of the Resolution and Plan of Action, SEAFDEC also started developing in close consultation with the Member Countries the plan for monitoring the progress made by the AMSs in the implementation of this important policy framework through the collection of baseline information. With this, we can closely identify the areas where assistance from SEAFDEC or other regional/international organizations is still required; and with support from various donors, particularly the Japanese Trust Fund, and others including through the projects supported by the Japan-ASEAN Integration Fund (JAIF), Food and Agriculture Organization of the United Nations (FAO), United Nations Environment Programme (UNEP), United States Agency for International Development (USAID), United States Department of the Interior (U.S. DOI), among others, it could be anticipated that the region would be able to make tangible progress in the implementation of the Resolution and Plan of Action in the upcoming years.

In this connection, I would like to take this opportunity to express my appreciation to all SEAFDEC Member Countries for the collaboration extended to SEAFDEC throughout the year, and to the SEAFDEC Council for providing valuable guidance that enabled the activities of SEAFDEC to be undertaken in a smooth and effective manner. Moreover, I also wish to express our appreciation to the Government of Japan and other donor organizations for providing support toward the successful implementation of our programs and projects.

We look forward that 2023 would be an even more intense implementation of our programs and projects, and SEAFDEC would commit itself to rendering our best efforts to support the countries in the region toward the sustainable development and management of fisheries in the coming years.



Ms. Malinee Smithrithee
Secretary-General

LIST OF ACRONYMS

ACDS	ASEAN Catch Documentation Scheme
AMAF	ASEAN Ministers on Agriculture and Forestry
AMSS	ASEAN Member States
AQD	SEAFDEC Aquaculture Department
ASEAN	Association of Southeast Asian Nations
ASPIC	A Stock-Production Model Incorporating Covariates
ASSP	ASEAN–SEAFDEC Strategic Partnership
ASWGF	ASEAN Sectoral Working Group on Fisheries
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CPUE	Catch Per Unit Effort
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
FRA	Fisheries Research and Education Agency, Japan
GEF	Global Environmental Facility
GESI	Gender Equality and Social Inclusion
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
LOA	Letter of Agreement
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
RFVR	Regional Fishing Vessels Record
RPOA	Regional Plan of Action
RS	Remote Sensing
SDGs	Sustainable Development Goals
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 2022

Chairpersons of the SEAFDEC Council

Mrs. Vilayphone Vorraphim (*until 23 May 2022*)

Mr. Haji Mohd Sufian bin Sulaiman (*since 23 May 2022*)

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: **Mr. Ing Try**
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** (*until 3 March 2022*)
Chairman of the Agency for Marine and Fisheries Research
and Human Resources, Ministry of Marine Affairs and
Fisheries
Mr. I Nyoman Radiarta (*since 4 March 2022*)
Chairman of the Agency for Marine and Fisheries
Research and Human Resources, Ministry of Marine
Affairs and Fisheries

Japan

Council Director: **Mr. Takashi Koya** (*until 18 March 2022*)
Director-General, Fisheries Agency of Japan
Ms. Miwako Takase (*since 19 March 2022*)
Councillor, Resources Management Department, Fisheries
Agency of Japan



Alternate Council Director: **Mr. Masahiro Takehana** (*until 12 September 2022*)
Director, First Country Assistance Planning Division,
International Cooperation Bureau, Ministry of Foreign
Affairs
Mr. Ishimaru Jun (*since 13 September 2022*)
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: **Dr. Kaviphone Phouthavong**
Deputy Director-General, Department of Livestock and
Fisheries

Malaysia

Council Director: **Mr. Ahmad Tarmidzi bin Ramly, AMK** (*until 2 January 2022*)
Director-General, Department of Fisheries Malaysia
Mr. Haji Mohd Sufian bin Sulaiman (*since 21 April 2022*)
Director-General, Department of Fisheries Malaysia

Alternate Council Director: **Mr. Mohd Mohtar bin Mahamud** (*until 30 December 2022*)
Deputy Director-General of 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** (*until 18 July 2022*)
Undersecretary for Agri-industrialization and for Fisheries,
Department of Agriculture

Alternate Council Director: **Mrs. Drusila Esther E. Bayate** (*until 18 July 2022*)
Assistant Director for Technical Services, Bureau of
Fisheries and Aquatic Resources

Singapore

Council Director: **Dr. Tan Lee Kim** (*until 30 June 2022*)
Director-General of Food Administration, and Deputy Chief
Executive Officer, Singapore Food Agency
Mr. Chan Hian Lim (*since 1 July 2022*)
Deputy Chief Executive Officer (Corporate, Industry &
Technology), Singapore Food Agency

Alternate Council Director: **Mr. Lim Huan Sein**
Director of Aquaculture Department,
Singapore Food Agency

Thailand

Council Director: **Mr. Mesak Pakdeekong** (*until 27 March 2022*)
Director-General, Department of Fisheries
Mr. Chalermchai Suwannarak (*since 28 March 2022*)
Director-General, Department of Fisheries

Alternate Council Director: **Mr. Taworn Thanjai**
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 2022

Secretary-General

Ms. Malinee Smithrithee

Deputy Secretary-General

Mr. Koichi Honda (until 31 May 2022)

Dr. Nakazato Tomoko (since 1 June 2022)

Training Department (TD)

Chief

Ms. Malinee Smithrithee

Deputy Chief

Mr. Koichi Honda (until 31 May 2022)

Dr. Nakazato Tomoko (since 1 June 2022)

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. Masaya Katoh (Acting, until 14 March 2022)

Mr. Abd. Haris Hilmi bin Ahmad Arshad (since 15 March 2022)

Deputy Chief

Dr. Masaya Katoh (until 31 March 2022)

Dr. Masahito Hirota (since 1 April 2022)

Inland Fishery Resources Development and Management Department (IFRDMD)

Chief

Mr. Zulkarnaen Fahmi

Deputy Chief

Dr. Toshiya Suzuki (until 31 March 2022)

Mr. Tomohito Shimizu (since 1 April 2022)

OVERVIEW OF SEAFDEC PROGRAMS IN 2022

The activities of SEAFDEC in 2022 were formulated and implemented in line with the policy directives given by the SEAFDEC Member Countries during SEAFDEC annual meetings, *i.e.* Forty-fourth Meeting of the SEAFDEC Program Committee (15–17 November 2021, online meeting), Twenty-fourth Meeting of the Fisheries Consultative Group of the ASEAN–SEAFDEC Strategic Partnership (FCG/ASSP) (24–25 November 2021, online meeting), and Fifty-fourth Meeting of SEAFDEC Council (23 and 25 May 2022, online meeting).



Delegates attending the Fifty-fourth Meeting of the SEAFDEC Council organized through the virtual platform

Moreover, the development and implementation of the SEAFDEC programs and activities for 2022 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 41st Meeting of the ASEAN Ministers on Agriculture and Forestry on 5 August 2020, 42nd 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 2022 was considered and endorsed by the Forty-fifth Meeting of the SEAFDEC Program Committee organized on 5–7 December 2022 and the Twenty-fifth Meeting of the Fisheries Consultative Group of the ASEAN-SEAFDEC Strategic Partnership (FCG/ASSP) on 8–9 December 2022, both in Iloilo City, Philippines; and would be submitted to the SEAFDEC Council at its Fifty-fifth Meeting in 2023.



National head delegates of the SEAFDEC Member Countries together with the SEAFDEC Secretary-General, SEAFDEC Deputy Secretary-General, and Guest of Honor attending the Forty-fifth Meeting of the SEAFDEC Program Committee



National head delegates of the ASEAN–SEAFDEC Member Countries together with the SEAFDEC Secretary-General, SEAFDEC Deputy Secretary-General, and representative from the ASEAN Secretariat attending the Twenty-fifth Meeting of the FCG/ASSP

The programs and projects implemented by SEAFDEC in 2022 are shown below:

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

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

Projects	Lead Department	Funding Source
6. Fisheries Management Strategies for Pelagic Fish Resources in the Southeast Asian Region	MFRDMD	JTF
7. Management Scheme for Inland Fisheries in the Southeast Asian Region	IFRDMD	JTF
8. Small-scale Fisheries Management for Better Livelihood and Fisheries Resources	TD	JTF
9. Establishment and Operation of a Regional System of Fisheries <i>Refugia</i> in the South China Sea and Gulf of Thailand	TD	UNEP/GEF
10. Strengthening the Effective Management of Inland Fisheries and Aquaculture in AMSs with GIS and RS Technology	SEC	JAIF
11. Sustainable Utilization of Anguillid Eels in the Southeast Asian Region	IFRDMD	JTF
12. Development of Stock Assessment Methods and Strengthening of Resources Management Measures for Tropical Anguillid Eel in Southeast Asia	SEC	JAIF
13. Regional Collaborative Research and Capacity Building for Monitoring and Reduction of Marine Debris from Fisheries in Southeast Asia	TD	JAIF
14. ASEAN-JICA Capacity Building Project on IUU Fishing Countermeasures in Southeast Asia*	TD	JICA
Strategy II: Supporting the sustainable growth of aquaculture to complement fisheries and contribute to food security, poverty alleviation and livelihood of people in the region		
15. Sustainable Aquaculture through Cost-effective Culture Systems, and Prompt and Effective Aquatic Animal Health Management	AQD	JTF
Strategy III: Ensuring the food safety and quality of fish and fishery products for the Southeast Asian region		
16. Enhancing Food Safety and Competitiveness of Seafood Products	MFRD	JTF
17. ASEAN-JICA Food Value Chain Development Project*	SEC	JICA
Strategy IV: Enhancing trade and compliance of the region's fish and fishery products with market requirements		
-		
Strategy V: Addressing cross-cutting issues, such as labor, gender and climate change, where related to international fisheries		
18. Assistance for Capacity Development in the Region to Address International Fisheries-related Issues	SEC	JTF

Projects	Lead Department	Funding Source
Strategy VI: Empowering SEAFDEC to strengthen its roles in the region and to improve its services to Member Countries		
19. Fisheries Resource Survey and Operational Plan for M.V. SEAFDEC 2	TD	JTF

* Projects not implemented in 2022 due to the ongoing budget approval process

2) Departmental Programs

Programs	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. Collaborative projects with the Philippine Government	AQD	AQD*
6. Improvement of Fisheries Technology and Reduction of the Impact from Fishing Activities	AQD	AQD*
7. Promotion on Strengthening of SEAFDEC Visibility and Enhancing Human Capacity Building	TD	TD*
8. SEAFDEC Capacity Development through USAID Sustainable Fish Asia Activity	TD	USAID

* From the regular contributions of the respective host Governments

3) Other Programs

Programs	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. 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 Resource	SEC	FAO

SEAFDEC PROGRAMS OF ACTIVITIES IN 2022

The programs of activities of SEAFDEC have been formulated and undertaken in response to the requirements of the Member Countries. This was the same for the year 2022, 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 2022 had been structured in this Annual Report 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.

Although the COVID-19 situation impeded the activities of SEAFDEC since early 2020 and was prolonged until 2022, restriction measures in several Member Countries had been more relaxed during the second half of 2022. The activities of SEAFDEC were therefore undertaken not only through online or hybrid platforms but also onsite. Several national activities were carried out by the SEAFDEC Departments not only in their respective host countries but also in other Member Countries where possible.

The results and progress of the programs and activities of SEAFDEC implemented in 2022 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

Fishery resources are a primary source of protein and contribute to the well-being and livelihoods of people worldwide. However, the growing human populations as well as the development of fishery-related industries have accelerated the demand for fish and fishery products resulting in the overexploitation of several marine species as well as the deterioration of marine habitats and ecosystems. Although countries in the region with support from relevant regional/international organizations have carried out initiatives at various levels aiming at the sustainable utilization and enhancement of marine and coastal fisheries resources and the ecosystem, the status of several marine fishery resources is still in the declining trend. Therefore, the effort toward sustainable utilization and enhancement of marine and coastal fisheries resources in the region needs to be further strengthened.

Toward this effort, SEAFDEC/TD has been implementing the project “**Sustainable Utilization of Marine Fisheries Resources and Resource Enhancement in Southeast Asia**” from 2020 to 2024. The Project aims to strengthen the sustainable management of marine fishery resources in Southeast Asia by improving technical and research capacities through organizing capacity-building training courses, meetings, and seminars; conducting fisheries and environment research surveys; promoting the application of Fisheries Geographic Information System (FGIS) and Remote Sensing (RS); and publishing standard operation procedures (SOPs) for evaluating the implementation of fishery resources enhancement activities.

For the human capacity development activities, TD conducted four regional training courses in 2022. The “Regional Training Course on Fish Population Dynamics and Fisheries Management Using R-statistical Program” was organized at the TD premises in Samut Prakan, Thailand on 8–12 August 2022. Attended by 18 fisheries officers and researchers from the ASEAN Member States (AMSs), the Training Course was aimed at strengthening the capacity of the participants on fish population dynamics and fisheries management using the R-statistical program and sharing the updated information on population dynamics of transboundary species in the region. In addition to the R-statistical program, the training also covered biostatistical analyses, estimation parameters in fish population dynamics by using R packages, and so on.



Regional Training Course on Fish Population Dynamics and Fisheries Management Using R-statistical Program on 8–12 August 2022 in Samut Prakan, Thailand

The “Regional Training Course on Marine Debris and Microplastics Sampling Collection and Analysis” was conducted on 18–25 August 2022 also at the TD premises. The aims of the training were to build up the capacity of researchers on marine debris and microplastic sample collection and analysis and strengthen the network of marine debris and microplastic researchers in the region. There were 25 participants from the AMSs



Regional Training Course on Marine Debris and Microplastics Sampling Collection and Analysis on 18–25 August 2022 in Samut Prakan, Thailand

who attended the Training Course that provided knowledge of the world marine debris situation, management of marine debris and microplastics, and survey methodology for seafloor debris. The trainees also carried out exercises on sampling techniques and data analysis using the R program, among others.

The “Regional Training Course on Determining Spawning-Nursing Ground and Season Using Larvae Survey Results” was conducted during 28 November–3 December 2022 in Samut Prakan, Thailand. There was a total of 72 trainees who attended this training course to improve their knowledge, skill, and experience to utilize data from fish larvae survey by integrating with other skills, *e.g.* GIS, R statistics software, and aging analysis to determine the fish spawning/nursing ground and season. It should be noted that this Training is Phase II of the Regional Training Course on Fish Larvae, Phase I of which was conducted on 16–27 November 2022 focusing on larval fish identification and fish early life history science with support from the UNEP/GEF Fisheries *Refugia* Project (*see Section 1.7 Establishment and Operation of a Regional System of Fisheries Refugia in the Southeast China Sea and Gulf of Thailand*).



Regional Training Course on Determining Spawning-Nursing Ground and Season Using Larvae Survey Results on 28 November–3 December 2022 in Samut Prakan, Thailand

Another training organized by TD was the “Regional Practical Training Course on Geographic Information System (GIS) and Remote Sensing (RS) for Aquaculture” on 6–9 December 2022 also in Samut Prakan, Thailand. The Training was attended by 19 junior fisheries officers and researchers from the AMSs who are involved in fisheries and aquaculture in their respective countries. The lectures and exercises during the training course focused on the use of GIS and RS for the selection of potential sites for green mussel aquaculture in the coastal area. It is expected that the participants would be able to apply the knowledge and skills on the use of GIS and RS for aquaculture development and management in their respective country in the future.



Regional Practical Training Course on Geographic Information System (GIS) and Remote Sensing (RS) for Aquaculture on 6–9 December 2022 in Samut Prakan, Thailand

With regard to the activity on fisheries and environment research surveys, TD conducted from 23 to 28 January 2022 the cruise survey in Thai waters to compare the catch per unit effort (CPUE) of fisheries resources survey by trawling between M.V. SEAFDEC 2 and research vessel of the Department of Fisheries Thailand. In 2022, TD also supported the development of four draft cruise plans using M.V. SEAFDEC 2, namely: 1) in the Philippines for biomass and oceanographic survey utilizing M.V. SEAFDEC 2 as the research platform in order to determine the volume of stocks of the candidate species, *Sardinella lemuru* (Bali sardinella) present in the natural environment to demonstrate its sustainability; 2) fisheries and oceanographic surveys in Myanmar; 3) fisheries and oceanographic surveys in Thailand; and 4) shipboard survey entitled “Marine Environment and Fishery Resources Survey by Using a Research Vessel and Evaluate the Impacts of Microplastics on the Fisheries Resources” which is to be undertaken under the project supported by the Japan-ASEAN Integration Fund (JAIF) in 2023.

Moreover, this Project also supported the development of “Standard Operation Procedures (SOPs) for the Evaluation of Artificial Reefs Installation to Enhance Marine Resources.” An environmental survey was conducted at Baan Klong Makham in Trat Province, Thailand where fishers were interested to enhance fishery resources through the deployment of fish enhancing devices (FEDs). As a result from this activity, it is expected that the SOPs for FEDs would be published in 2023.

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

In 2022, 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 due to their high abundance in the waters of the AMSs and the need to establish efficient fisheries management strategies for the respective stocks. This Project also involves the genetic study of pelagic fish species in the region as well as a study of the life history of the species through age determination

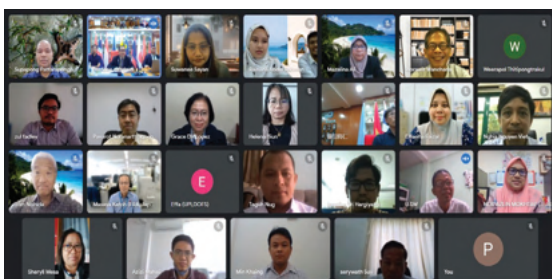


Second Core Expert Meeting on Fisheries Management Strategies for Pelagic Fish Resources in the Southeast Asian Region on 28–29 September 2022, online meeting

analysis. This 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 2022 under the activity on “stock assessments and risk assessments for small pelagic fishes in the Southeast Asian region,” MFRDMD continued to compile the data from the participating AMSs for three small pelagic species, *i.e.*, *Rastrelliger kanagurta*, *R. brachysoma*, and *Decapterus* spp., through the questionnaire. The “Second Core Expert Meeting on Fisheries Management Strategies for Pelagic Fish Resources in the Southeast Asian Region” was organized on 28–29 September 2022 through the online platform to share the Project’s progress, particularly the current stock status of three selected small pelagic species based on the data provided by the respective AMSs, and discuss the appropriate stock assessment analysis. However, the existing data were still incomplete, thus the Meeting was not able to determine the appropriate analysis method. MFRDMD would continue following up with the AMSs to obtain information and complete the required data. At this Meeting, the way forward of the Project for the remaining years was also discussed.

Under another activity on “stock assessments and risk assessments for major neritic tuna species in the Southeast Asian region,” MFRDMD organized the “Seventh Meeting of the Scientific Working Group for Neritic Tunas (SWG-Neritic Tunas)” on 23–24 August 2022 through online platform. During this meeting, the representatives from the AMSs shared their countries’ current stock status of two seerfish species (*Scomberomorus commerson* and *S. guttatus*). On the other hand, MFRDMD also shared the outputs of the Internal “Workshop on Seerfish in Malaysia Waters using ASPIC.” This internal workshop was held in collaboration with the Department of Fisheries (DOF) Malaysia in December 2021. Finally, MFRDMD also presented the progress of the population study and life history study of kawakawa (*Euthynnus affinis*). It was planned that MFRDMD would conduct a regional workshop on the neritic tuna or tuna-like species in the fourth quarter of 2023.



SWG-Neritic Tunas on 23–24 August 2022 in Kuala Terengganu, Malaysia and online

MFRDMD also continued the activity on “clarification of the stock structure for one neritic tuna species in the Southeast Asian region.” A total of 710 kawakawa (*E. affinis*) samples were collected from 15 locations in Southeast Asia since the past Project term. As for the current activity, the samples were analyzed using the mitochondrial DNA d-loop region, and a total of 430 DNA samples were successfully sequenced, generating 275 haplotypes. The phylogenetic analysis using the maximum likelihood (ML) tree method displayed no obvious separation pattern for all populations and the AMOVA analysis also revealed a high contribution within the population. The study suggested that the *E. affinis* population in the Southeast Asian region was panmictic with shallow genetic structure due to high gene flow. The results of this study were presented by MFRDMD at the “Seventh Meeting of the Scientific Working Group for Neritic Tunas” on 23–24 August 2022, “46th Annual Conference of the Malaysian Society for Biochemistry and Molecular Biology 2022” held on 24–25 August 2022, and “Second Core Expert Meeting on Fisheries Management Strategies for Pelagic Fish Resources in the Southeast Asian Region” on 28–29 September 2022.

Under another Project activity on “life-history study for major neritic tuna species in the Southeast Asian region,” approximately 35 samples of kawakawa (*E. affinis*) were collected from Kuala Besut in Kuala Terengganu and/or from Tok Bali in Kelantan each month from January to December 2022, making a total of 623 samples to be used for assessment of the age structure of *E. affinis* populations on the northeast of Peninsular Malaysia. Although laboratory work for this study is still underway, MFRDMD has already analyzed 360 samples with estimated ages ranging from one to seven years. The average age of *E. affinis* populations in the northeast of Peninsular Malaysia was approximately four years, and their average fork length was about 423.10 mm. It is worth noting that the L_{∞} of the populace in this area was 542.95 mm. The preliminary results of the life-history research of *E. affinis* were published in the Special Report of SEAFDEC Newsletter Volume 45 No. 2 with an emphasis on how this study could contribute to science-based management approaches to reduce fishing pressure, particularly on *E. affinis* populations in the northeast of Peninsular Malaysia.

1.2 Assessment and management of inland fisheries

Management Scheme for Inland Fisheries in the Southeast Asian Region

Inland fisheries are a part of life for rural people inhabiting the border of a wide range of inland water bodies, especially those living in the middle and low economic levels, utilizing the water bodies for capture fisheries and aquaculture as sources of food and income. Despite its significant contribution to a large number of people, inland fisheries have mostly been undervalued and overlooked, and have yet to receive serious attention from most public services and governments. Indeed, due to a lack of reliable data, inland fisheries have never been of any high profile in global fisheries assessment and are notably absent from the Sustainable Development Goals of the United Nations. In 2022, IFRDMD continued to implement the ongoing project “**Management Scheme for Inland Fisheries in the Southeast Asian Region**” which commenced in 2021 and is scheduled to complete in 2024. The Project aims to achieve two main outputs: 1) policy and recommendations for inland fisheries management in Southeast Asia; and 2) assemblage of fish catch data and information.

Under the activity on inland fishery management, in Indonesia, IFRDMD initiated a collaboration with stakeholders in the Riau Province to strengthen the collaborative work and transfer knowledge as well as obtain feedback from stakeholders concerning inland fisheries management. On 16–20 February 2022, IFRDMD visited the business sector representatives from the fishery government agency in Kampar District, Marine and Fishery Faculty of Riau University (UNRI), and Kampong Patin. The concerns of IFRDMD were on the support program at the local government level on data collection, capacity building, and promotion of the inland fishery potential of the Kampar District; and meeting with the potential stakeholders could develop an understanding of the current utilization status of inland waters and fishery resources. In Kampong Patin, IFRDMD saw the successful collaborative work between the local people and the government that integrated aquaculture, postharvest activities, education, and tourism.



IFRDMD activities in Indonesia: meeting with the fishery officers in Kampar District (left), smoked fish processing in Kampong Patin (middle), and meeting with the academic professionals of Riau University (right)

For Cambodia, IFRDMD conducted a survey on 29 September–6 October 2022 in collaboration with the country's Fisheries Administration (FiA) and fishery agency in Kampong Cham Administration of Cantonment. IFRDMD conducted a number of activities in Kampong Cham, such as collection of fish catch data, training on reporting fishery data, and evaluation of fishery management based on ecosystem approach to fisheries management (EAFM) for inland fisheries. Moreover, IFRDMD also conducted awareness raising activities for the fishery agency and fishers from potential fishers groups on data collection and fishery resources management considering that one of the typical issues faced by most countries in the region is the need for more data to support fishery management. While transferring the knowledge to relevant agencies and fishers, IFRDMD could also obtained feedback and a better understanding of the needs for inland waters management of the country.



IFRDMD activities in Cambodia: meeting with the fishery officers of the Kampong Cham Administration of Cantonment (left), training on data collection for local fishers (middle), and data collection on EAFM for inland fisheries (right)

For better management and utilization of inland fisheries, IFRDMD conducted several activities including training and workshops aimed at improving the capacity of women in fisheries and established the guideline for the conservation of fishery resources in swamps and peatlands. In order to enhance the ability of women to participate in the fishery sector, access and control resources and benefits and take part in decision-making, IFRDMD organized a series of workshops on enhancement of women’s participation in inland fishery activities to support family welfare in Patratani Village, Muara Enim, South Sumatra Province on 15 June 2022 and Kampong Patin, Kampar District, Riau Province on 14 July 2022. IFRDMD also disseminated the guideline entitled “Remodeling swamp fisheries: conservation areas” in the Regent of Ogan Komering Ilir (OKI), Kayu Agung, South Sumatra Province, Indonesia to fisheries stakeholders, including the community, government, and interested parties on 29 November 2022.



IFRDMD activities on improving the utilization and management of inland fishery resources through workshops, training, and dissemination of conservation guidelines in Indonesia: training for women in Patra Tani Village (left) and Kampar (middle), and dissemination of fish conservation guidelines (right)

Besides the collaboration on assessing the inland fisheries activities in the AMSs, IFRDMD also made field visits and observations of fisheries activities. IFRDMD visited a fish sanctuary called “Lubuk Larangan” in Kampar District, Riau Province, Indonesia on 19 February 2022, which was established based on local wisdom to protect fishery resources. To date, “Lubuk Larangan” is still managed under local regulation by the villages, and around 50 locations have been reported in Kampar District. IFRDMD would support the local government to endorse such local wisdom at the government regulation level.



Fish sanctuary known as “Lubuk Larangan” established based on local wisdom in Kampar District: Danau Tanjung Putus sanctuary (left), Danau Baru sanctuary (middle), and barrier trap (right)

In Kampong Cham Province, Cambodia, the area is endowed with rich fishery resources from the Mekong River that are essential for people living nearby. On 2 October 2022, IFRDMD visited the local fish market, met with sellers and fish business owners, and shared the knowledge that resource diversity and availability should be conserved. Moreover, it was observed that the sources of fish and fishery products in the market have been shifted from captured to aquaculture, while the support in terms of funding and business regulation was significant in sustaining the welfare of the fisheries sector of the Province.



Visit to the fish market and identification of fish products from the Mekong River in Kampong Cham, Cambodia

The effectiveness of the Special Area for Conservation and Fish *Refugia* (SPECTRA) in Patratani, Muara Enim, Indonesia, which was introduced by IFRDMD in 2020, was evaluated from January to November 2022 by observing and assessing the water dynamics and land cover and conducting biological study. Water dynamics were observed for 24 hours cycle each month to evaluate the changes in water quality as an abiotic component of the SPECTRA. The peak and poorest conditions of the water bodies were identified and noted as the critical time. For land cover monitoring, this was undertaken to support the prediction of the change in water coverage in the SPECTRA system with a view to improve the understanding of fishing activity in the fishing ground, which can fit into management measures and evaluation. As for the biological study, the data, *e.g.* length and weight of samples of three dominant fish species were collected monthly. The fish species found in the SPECTRA system were compared to the species from outside or in the Musi River, the results of which showed that the SPECTRA species could adapt to the environment well, as indicated by their growth value, condition factor, and length distribution compared to the fish outside the SPECTRA system.



Evaluation of SPECTRA in Patratani, Muara Enim, Indonesia: water fluctuation monitoring (left), land cover observation using drone (middle), and biology study of fish species (right)

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 the visualization, monitoring, and assessment of resources, and the results of which could be used in preparing appropriate planning and management strategies for the sustainable utilization of resources. The project **“Strengthening the Effective Management of Inland Fisheries and Aquaculture in AMSs with GIS and RS Technology”** was implemented starting from 2019 by the SEAFDEC Secretariat in collaboration with TD

with support of the Japan-ASEAN Integration Fund (JAIF). The original plan was to complete the project in June 2020 but the planned activities could not be implemented due to the restrictions caused by the COVID-19 pandemic; thus, the Project was extended until December 2022.

The Project was aimed at developing methods for monitoring inland fisheries using the GIS and RS technologies by investigating the relationship between catch quantity and environmental data through GIS mapping. The five Project pilot sites in the AMSs include: 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. The activities of the Project were: 1) collection of catch using logbook of fishers in the pilot sites; 2) collection of environmental data from a satellite; 3) analysis of the relationship between catch data and environmental factors. As the data and information collected from the pilot sites have already been completed in 2020, the Project planned to organize the in-person workshop for data analysis in 2021. However, due to the COVID-19 situation, only a trial of multivariate analysis could be conducted partly in 2021 to clarify the relationship between catch data and environmental data, and the workshop was rescheduled to 2022.



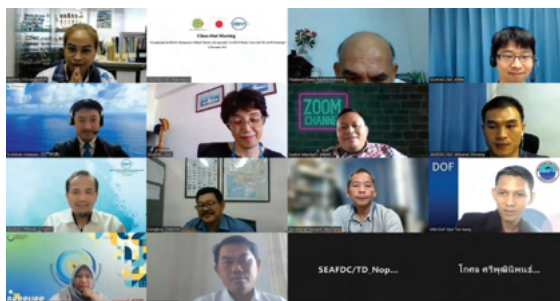
Location of Project pilot sites in Cambodia, Indonesia, Thailand, Lao PDR, and Myanmar

On 21–23 September 2022, the “Workshop on Analyzing Catch Data and GIS Data” was organized in Bangkok, Thailand with a total of 40 participants from the SEAFDEC Member Countries. The Workshop was aimed at analyzing the catch data and environmental data collected from the Project pilot sites as well as environmental data downloaded from satellite Sentinel-3 from the EUMETSAT portal. During the Workshop, the procedure of downloading environmental data from satellites and analyzing methods using the statistical software R and QGIS were practiced by the participants.

SEAFDEC also organized the Project Close-out Meeting on 23 December 2022 through an online platform with the aim of presenting the Project achievements. The Project successfully came up with three deliverables, namely: 1) manual for data collection on inland fishing site; 2) manual for downloading LST and CHL of Sentinel-3 from the EUMETSAT portal; and 3) manual for analysis of catch data. In addition, the Meeting also shared lessons learned, constraints, and recommendations for further work on the application of GIS and RS.



*Workshop on
Analyzing Catch
Data and GIS
Data on 21–23
September 2022 in
Bangkok, Thailand*



*Online Project Closeout meeting
on 23 December 2022*

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 SEAFDEC/TD starting in 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 originally aimed at the construction of one fish passage each in Cambodia, Thailand, and Viet Nam with the duration from 2018 until September 2020. As a result, the Project successfully completed the construction of a fish passage in Kbal Hong Weir in Cambodia in 2019, while the construction of another fish passage in Hauy Wang Chang Weir in Udon Thani Province, Thailand was completed in 2020. For Viet Nam, the construction of the fishway at Ea Tul weir in ĐắC Lac Province was

undertaken in 2021 and completed in 2022. It should also be noted that this Project was extended until 2022 with the construction of additional three fish passages in Cambodia at Srei Snom Spillway, Romlech I Spillway, and Romlech II Spillway, which were also completed in 2022.

To conclude the Project, TD organized the “Smart Infrastructure for the Mekong Closeout Workshop” on 18 October 2022 at its premises in Samut Prakan, Thailand. Aiming to present and discuss the results of the Project, the Workshop had a total of 49 participants from the U.S. Government, SEAFDEC, Cambodia, Lao PDR, Thailand, Viet Nam as well as relevant organizations. A demonstration model of the fishway was also showcased at the Workshop.

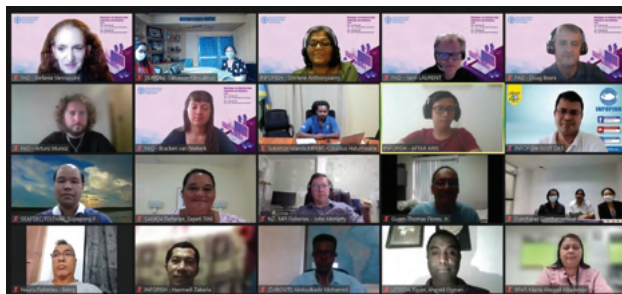


Smart Infrastructure for the Mekong Closeout Workshop on 18 October 2022 in Samut Prakan, Thailand

Achievements: Implementation the Lower Mekong Fish Passage Initiative

From 2018 to 2022, six fish passages constructions were successfully completed in Cambodia, Thailand, and Viet Nam at:

1. Kbal Hong Weir, Stung Pursat Watershed, Pursat province, Cambodia (2019)
2. Hany Wang Chang Weir, Udon Thani Province, Thailand (2020)
3. Ea Tul Weir, Đắc Lạc Province, Viet Nam (2021)
4. Srei Snom Spillway, Stung Sreng Watershed, Siem Reap Province, Cambodia (2022)
5. Romlech I Spillway, Pursat Province, Cambodia (2022)
6. Romlech II Spillway, Pursat Province, Cambodia (2022)



Online FAO Workshop on Fisheries Data Collection and Statistics (Global) on 8–9 November 2022

Another activity that was continued in 2022 was the revision of the Regional Framework for Fishery Statistics for Southeast Asia. In 2021, SEAFDEC convened the “First Regional Technical Consultation on Fishery Statistics and Information in Southeast Asia” that came up with the suggestions including the revision of the Regional Framework in the part Explanatory Notes, inclusion of statistics on fish processing and statistics on fish trade (export and import) for regional compilation as well as overall workplan for revising the Regional Framework. Thus, SEAFDEC proceeded this initiative by organizing the “Second Regional Technical Consultation on Fishery Statistics and Information in Southeast Asia” on 23–26 August 2022 in Chonburi Province, Thailand in 2022. The regional technical consultation (RTC) discussed and agreed on the revision of the Regional Framework for Fishery Statistics of Southeast Asia, specifically for the parts on marine and inland capture fisheries, aquaculture, fishers and fish farmers, and producer price. The RTC also supported the inclusion of new statistics items (*i.e.* statistics on small-scale and commercial fisheries, fishers and fish farmers disaggregated by nationality and gender, and per capita fish consumption) to recognize and highlight the importance of the contribution of fisheries to food security, small-scale fisheries, and gender inclusion.



Second Regional Technical Consultation on Fishery Statistics and Information in Southeast Asia” on 23–26 August 2022 in Chonburi Province, Thailand

As another Project component, the publication “Southeast Asian State of Fisheries and Aquaculture” or SEASOFIA 2022 was published and disseminated to the Member Countries, partner organizations, fisheries institutions and libraries, and individual recipients, while the electronic format was made available for download at the SEAFDEC Institutional Repository.

It should be also noted that this Project serves as a platform to disseminate the outputs and outcomes of the various projects implemented by SEAFDEC. In 2022, three issues of the Special Publication “Fish for the People” (Volume 20 Nos. 1–3) were published and disseminated to target audiences. Meanwhile, another regular publication of the SEAFDEC Secretariat, “Fishery Statistical Bulletin of Southeast Asia 2019” which includes a compilation of the fishery statistics from the respective AMSs in line with the harmonized Statistics Frameworks was published and disseminated in 2022, while the Bulletin 2020 was being prepared for publication in early 2023.



SEASOFIA 2022 (left) and Fishery Statistical Bulletin of Southeast Asia 2019 (right)



SEAFDEC Special Publication “Fish for the People” Volume 20 Nos. 1–3

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 Resource

The Sustainable Development Goals (SDGs) were adopted by the United Nations in 2015 as a universal call to end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity. One of the indicators for “Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development,” specifically for “Target 14.4: By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics” is “Indicator 14.4.1: Proportion of fish stocks within biologically sustainable levels.” A wide range of data and information is being compiled to support monitoring of the progress of the implementation of the SDG; however, there are still some data that are difficult to access, such as the data stored within the national institutions, written in local languages, unpublished data, grey literature, among others.

The project “**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 Resource**” was therefore formulated and supported by the FAO for SEAFDEC to implement activities on *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; and 3) research and data recorded by participants will undergo bibliometric analysis with results presented in a report. From 1 January 2022 to 30 November 2022, the Project was coordinated by the SEAFDEC Secretariat to work with Departments namely AQD, TD and MFRDMD, with assistance from the FAO/Aquatic Sciences and Fisheries Abstracts (ASFA) Secretariat and FAO/ Fisheries and Resources Monitoring System (FIRMS) Secretariat on relevant activities.

The Project has worked with institutions in data-poor countries in Southeast Asia to identify and record research publications and data related to SDG Indicator 14.4.1. In early 2022, the scope of the Project and search strategies were agreed upon to ensure that most of the research and datasets produced from the target countries will be covered. Subsequently, five training sessions were conducted on 12 July, 19 July, 26 July, 2 August, and 9 August 2022. A total of 15 participants, composed of information professionals and researchers from the academe, research institutions, and government agencies joined the training activities. The trainees from Cambodia, Indonesia, Philippines, and Viet Nam were provided with the knowledge of search strategies to gather relevant research and data and trained in creating records for different types of resources (including datasets) in OpenASFA. Subsequently, the trainees identified a total of 1,397 references to research publications or datasets which can be broken down into 1,047 records and 350 references from the ASFA database. The most numerous type of document was journal articles (702 references), followed by books which include reports and monographs (447 references), datasets (139 references), and book chapters (109 references). A total of 1,585 taxonomic names were also added as keywords to the research publications and datasets recorded.

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

For over a decade, SEAFDEC has implemented a number of programs and projects to develop regional frameworks and tools to support the actions of the AMSs to address illegal, unreported and unregulated (IUU) fishing in the region. In sustaining such efforts, TD continued to implement the project “**Strengthening a regional cooperation and enhancing national capacities to eliminate IUU fishing in Southeast Asia**” from 2020 to 2024. With the overall objective toward “sustainable utilization and sound management of fisheries resources in Southeast Asia,” the Project is expected to come up with four outputs, namely: 1) enhanced the Regional Fishing Vessels Record (RFVR) database, 2) strengthened national capacities in the implementation of port State measures (PSM) and monitoring, control and surveillance (MCS), 3) widely promoted electronic ASEAN Catch Documentation Scheme (eACDS), and 4) boosted coordination and promotion of national/regional/international network for collaborative activities to combat IUU fishing.

In 2022, TD organized the “Regional Workshop on Monitoring Control and Surveillance for Combating IUU Fishing in Southeast Asia” from 23 to 24 August 2022 in Chonburi Province, Thailand. The aims of the Workshop were to share and update information on monitoring, control and surveillance (MCS) implementation in the region, enhance and promote fisheries management tools for combating IUU fishing, and identify the needs for capacity building on MCS for combating IUU fishing. The progress of implementation of MCS activities was presented by the respective AMSs and relevant international organizations, including the Food and Agriculture Organization of the United Nations (FAO), ASEAN Network for Combating IUU Fishing (AN-IUU), Regional Plan of Action to Promote Responsible Fishing Practices including Combating IUU Fishing in the Region (RPOA-IUU) Secretariat, International MCS Network (IMCS), Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), Indian Ocean Tuna Commission (IOTC), Australian Fisheries Management Authority (AFMA), and Southern Indian Ocean Fisheries Agreement (SIOFA). Also, the participants were updated of the existing fisheries management tools for combating IUU fishing. In conclusion, the needs for capacity-building relevant to MCS for combating IUU fishing were identified by the Workshop.



Regional Workshop on Monitoring Control and Surveillance for Combating IUU Fishing in Southeast Asia on 23 to 24 August 2022 in Chonburi Province, Thailand

Under another scope of activity toward strengthening national capacities in the implementation of PSM, TD organized the “Regional Training Course on Port State Measures Inspection in Focus of Shipping Container for Fish and Fisheries Product” in collaboration with the U.S. National Oceanic and Atmospheric Administration (NOAA) and USAID from 13 to 15 September 2022. The Training was composed of lectures and practical exercises focused on building up the knowledge, skills, and experience of the participants on inspection of fish and fishery product importation via sea in container vessels.

On promoting the traceability of fish and fishery products, TD organized the “Regional Workshop to Exchange Information on Catch Documentation Scheme and Traceability of Fish and Fishery Products” from 29 to 30 November 2022 with speakers from CCAMLR, IOTC, Seafood Alliance for Legality and Traceability (SALT), FAO, and USAID. The Workshop provided the participants with updated information on the implementation of the traceability of fish and fishery products to combat IUU fishing and the way forward for the SEAFDEC Member Countries.



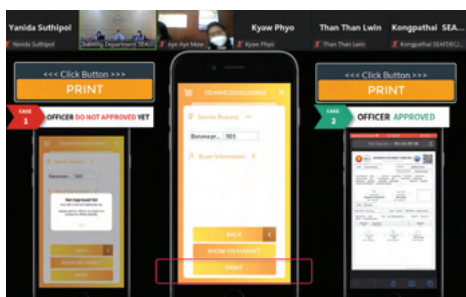
Regional Training Course on Port State Measures Inspection in Focus of Shipping Container for Fish and Fisheries Product on 13 to 15 September 2022 in Thailand



Regional Workshop to Exchange Information on Catch Documentation Scheme and Traceability of Fish and Fishery Products on 29 to 30 November 2022, Thailand

On the eACDS implementation, the pilot countries involved are Brunei Darussalam, Malaysia, Viet Nam, Myanmar, and Cambodia. For Brunei Darussalam, Malaysia, and Viet Nam where the development of eACDS application was already completed with corresponding training for relevant officers and stakeholders, TD proceeded in organizing the “Online Training on Preparation and Installation of the eACDS Application to Server” in Brunei Darussalam on 26–27 May 2022, Malaysia on 9–10 June 2022, and Viet Nam on 16–17 August 2022. This series of training was aimed at strengthening and enhancing the understanding of relevant officers on the preparation and installation of eACDS application, as a prototype for traceability of fish and fishery products, to the server of the respective countries.

For Myanmar where the eACDS application was already developed, TD continued the activities by organizing the “Online Training on the Use of eACDS Application in the Part of Movement Document (MD), Statement of Catch (SC), and Catch Certification (CC) for Myanmar” from 26 to 28 January 2022. The training was aimed at strengthening and enhancing the understanding of Myanmar officers on the use of the eACDS application. It is expected that the officers who attended this Training would further serve as trainers for other relevant stakeholders in Myanmar.



Online Training on the Use of eACDS Application in the Part of Movement Document (MD), Statement of Catch (SC), and Catch Certification (CC) for Myanmar on 26 to 28 January 2022

For Cambodia, the introduction of the eACDS was still at the initial stage. A discussion was conducted on 11 May 2022 with the Fisheries Administration of Cambodia on eACDS implementation and confirmation of the project site in Koh Kong Province. The Key Data Elements (KDEs) form was sent to Cambodia for information collection.

ASEAN-JICA Capacity Building Project on IUU Fishing Countermeasures in Southeast Asia

The project “**ASEAN–JICA Capacity Building Project on IUU Fishing Countermeasures in Southeast Asia**” was aimed at enhancing the capacities of the AMSs to prevent and combat IUU fishing through a series of training and/or workshop activities, and target staff of the government agencies responsible in conducting relevant activities to eliminate IUU fishing. The Project has three expected outputs, namely: 1) promoted responsible fishing technologies and practices to combat IUU fishing; 2) training on ASEAN Catch Documentation Scheme (ACDS) including onsite training for eliminating IUU fishing in Southeast Asia; and 3) enhanced policy measures to combat IUU fishing in the AMSs.

Although this ASEAN–JICA Project was approved by the SEAFDEC Council in 2021 to be implemented in 2022 provided that the fund could be secured, the administrative process in Japan in preparation for the Project has been delayed due to the COVID-19 situation in 2021–2022. In 2022, the planned activities and sub-activities including the Project budget allocations have not yet been finalized and confirmed; it is therefore expected that the Project activities could be confirmed and commence in 2023.

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 ecosystem approach to fisheries management (EAFM) concept in the AMSs through human resource development and pilot implementation at selected project sites. The initiative has been sustained by TD through its project “**Small-scale Fisheries Management for Better Livelihood and Fisheries Resources.**” Implemented from 2020 to 2024, the three main components of this Project include 1) Implementation of the EAFM in the pilot learning sites; 2) Capability development in the implementation of FAO Voluntary Guidelines for Securing Sustainable Small-scale Fisheries in the Context of Food Security and Poverty Eradication (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 the Southeast Asian countries.

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. The “Regional Training Course on Fisheries Management Tools for EAFM” was organized by TD from 12 to 17 September 2022 with eight fisheries officers from the AMSs attending. Moreover, at the national level, the “National Training Course on Fisheries Management Tools for EAFM” was conducted for the officers of the Department of Fisheries (DOF) Thailand on 22–26 August 2022.

For the implementation of the EAFM at pilot learning site, the “Training on Fisheries Management at the EAFM Learning Site in Ranong Province, Thailand” was conducted in Ban Hat Sai Khao Village in Ranong Province on 20–25 June 2022 to enhance the fisheries officers’ and local fishers’ knowledge of fisheries laws and regulations as well as of the MCS.

A meeting was also conducted with local fishers and other stakeholders to promote the importance of aquatic resource conservation and management, especially through the establishment of a “squid bank.”



Regional Training Course on Management Tools for Ecosystem Approach to Fisheries Management regional levels on 12–17 September 2022



National Training Course on Management Tools for Ecosystem Approach to Fisheries Management on 22–26 August 2022 in Thailand

In 2022, TD also promoted the EAFM implementation in Myanmar. An online meeting was conducted with the DOF Myanmar on 15 June 2022. Chaungwa Village in Kawthaung, Myanmar was identified as the appropriate site for the establishment of fisheries management unit (FMU). Subsequently, TD organized the “EAFM Training Workshop in the Learning Site at Kawthaung, Myanmar “from 29 August to 2 September 2022. The Training Workshop was participated by the EAFM Core team from Myanmar, key officers from the DOF in Kawthaung, and key stakeholders of Chaungwa Village. A discussion was made on the FMU including goals, constraints and opportunities, and operational objectives and indicators and benchmarks related to the agreed objectives. The EAFM plan including monitoring and evaluation of the management actions were also developed.

For Cambodia, TD organized an online meeting with the FiA of Cambodia on 20 May 2022 on the implementation of inland EAFM in Boeung Tonle Chhmar in the northern part of the Tonle Sap Lake which is an important breeding and nursing ground for fish. TD subsequently organized the “Workshop on Key Stakeholder Engagement to Finalize the EAFM Plan in Boeung Tonle Chhmar, Cambodia” on 19 July 2022. The Workshop was participated by the EAFM core team from Cambodia and provincial and local officers from Boeung Tonle Chhmar. Management activities and procedure for implementing the activities including the financial support were defined. On 14–15 November 2022, the “Meeting to Finalize the EAFM Plan for Boeung Tonle Chhmar, Tonle Sap Lake, Cambodia” was conducted to revisit and finalize the EAFM plan for this Project learning site.



Finalization of the EAFM plan for Boeung Tonle Chhmar, Tonle Sap Lake, Cambodia

Under **the second component**, the Fisheries Management Plan for Krabi Province, Thailand which was developed in 2021 was handed over to the Governor of Krabi Province in 2022. To follow up, TD carried out a study on the development plan to support fishing communities by enhancing their product development and marketing to promote income generation for small-scale fishers in Krabi Province. Moreover, a meeting was organized on the initial implementation of the eACDS for small-scale fisheries in Ban Nainang Village in Krabi Province on 7–8 December 2022 which was attended by fishery officers from the DOF Thailand, fishers, and representatives from the private sector. During the Meeting, TD introduced the application of eACDS in small-scale fisheries especially the part of Catch Declaration (the use of catch report at sea and e-logbook) to enhance the value and marketing of fisheries products. The Key Data Elements (KDEs) for eACDS application were identified which would be collected by the DOF officers and send to SEAFDEC as inputs for the eACDS application. In the future, the fisheries officers and fishers in Baan Nainang will be trained on the utilization of the eACDS application.



Participants during the study on the development plan on enhancing product development and marketing for income generation of small-scale fishers in Krabi Province, Thailand

Under **the third component**, a series of “Training on Gender Mainstreaming in Fisheries Sector” was carried out by TD in collaboration with the IFRDMD in Indonesia on 6–8 September 2022 and MFRDMD in Malaysia on 25–27 October 2022. The trainings were participated by fisheries officers as well as staff of IFRDMD and MFRDMD. The objectives of the Training were to enhance the understanding of the participants of gender and relevant concepts, introduce gender mainstreaming tools, and recommend gender analysis framework in fisheries.



Training on Gender Mainstreaming in Fisheries Sector in Indonesia (left) and Malaysia (right)

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 gear and practices with a view of enhancing the sustainable utilization of marine and coastal fishery resources and minimizing the adverse impacts of fishing on the marine ecosystems and environment. In 2021, TD sustained such efforts through the project **“Responsible Fishing Technology and Practice.”** The Project duration is from 2020 to 2024 with the aims to: 1) promote responsible fishing technology and practices to mitigate fishing impacts on the marine ecosystem, 2) promote marine engineering technologies and their applicability in enhancing the capability of fuel consumption efficiency and safety in fishing operations, and 3) enhance human resource capacities on fish handling techniques onboard fishing vessels.

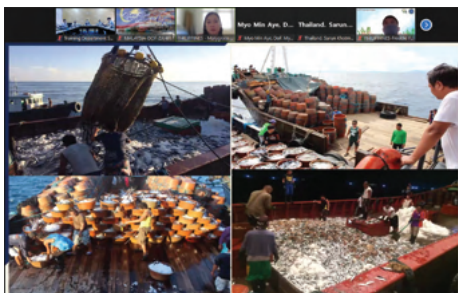
For the scope of activities on promotion of responsible fishing technologies and to reduce/mitigate impacts on the marine ecosystem, TD continued the development and improvement of marine engineering technologies, *i.e.* enhancement of fuel efficiency, reduction of greenhouse gas emission from fishing activities, and promotion of the safety of fishing operations at sea, at the national and regional levels. A study to enhance fuel efficiency while producing cooling media to reduce post-harvest loss and prolong freshness quality at premium quality was carried out using the M.V. PLALUNG from the second to the fourth quarter of 2022 in Pattani Province, Thailand. TD also organized the “Online Regional Training Course on Energy Audits for Fishing Vessels” from 21 to 23 June 2022. Sixteen participants from the AMSs participated in the Training Course that successfully imparted the knowledge of fishing vessel energy audits to support the mitigation of climate change and methods to reduce greenhouse gas emissions from capture fishery.



Online Regional Training Course on Energy Audits for Fishing Vessels on 21–23 June 2022

To enhance human resource capacities on fish handling techniques onboard fishing vessels, TD organized the “Online Regional Training Course of Fish Handling Techniques Onboard Fishing Vessels” from 28 to 30 June 2022. Attended by fourteen participants from the AMSs, the Training Course provided knowledge of the simple techniques on the application of hygienic environment-/user-friendly fish handling tools to maintain the quality of catch onboard fishing vessels. Practical skills and concepts related to the reduction of post-harvest losses in fisheries, including fish handling techniques, ice storage, preservation techniques, and transportation of fishery products were imparted to the trainees.

TD also organized the “On-site Training on Fish Handling Onboard Fishing Vessels in Thailand” on 8 July 2022 at the Prince of Songkla University, Pattani Campus. Attended by 20 participants including fishers, vessel owners, and other relevant stakeholders in Thailand, the Training Course focused on fish handling practices, cold chain management, and the applicable preservation techniques for improving fish handling onboard.



Online Regional Training Course of Fish Handling Techniques Onboard Fishing Vessels on 28–30 June 2022



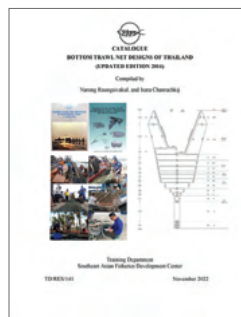
On-site Training on Fish Handling Onboard Fishing Vessels in Thailand on 8 July 2022 in Pattani Province, Thailand

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 “**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) develop database for fisheries management.

Under the first scope of activities, TD was in the process of developing the Handbook of the Scientific Echo Sounder EK 80 for M.V. SEAFDEC 2 in 2022 subsequent to the installation of the scientific echo sounder SIMRAD EK-80 onboard the M.V. SEAFDEC 2 in 2021. The Handbook would provide simple guidance for relevant officers or operators to use and operate the instrument. However, the process to obtain updated information and lessons learned from relevant researchers was still ongoing and the Handbook is expected to be completed by the end of 2023.

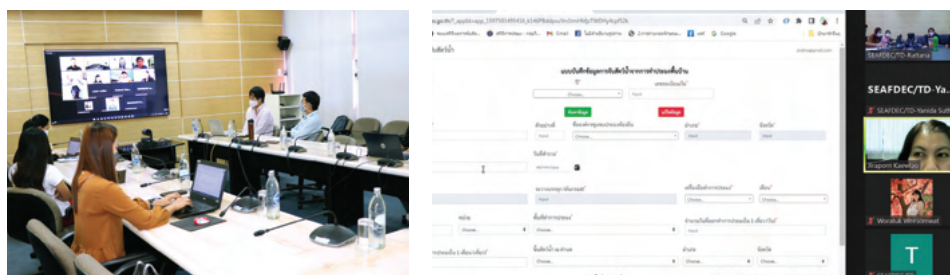
TD was also in the process of developing the document “Basic Knowledge of Fishing Gear: Gillnet (*in Thai*)” while the “Catalog of the Bottom Trawl Net Designs of Thailand” was already completed in December 2022 and disseminated online through the TD Institutional Repository. The two documents are envisaged to serve as references for improving and monitoring fishing technology to support fisheries management in Thailand and for other specific purposes.



Catalog of the Bottom Trawl Net Designs of Thailand

Under the second scope of activities, 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 planned for 2022. Data on the floating marine debris at the mouth of the Chao Phraya River has been recorded twice a week for 12 months. The model to assess the amount of floating debris runoff from the Chao Phraya River was determined in collaboration between TD and an expert from the Tokyo University of Marine Science and Technology (TUMST), Japan. However, the analysis of data was postponed due to the unavailability of the TD researcher who is on study leave.

For the third scope of activities on the proposed development of a database system to compile fisheries socioeconomic information and small-scale fisheries studies, the “Meeting on the Development of a Database System for Small-scale Fisheries” was organized on 27 April 2022 and 10 May 2022 attended by fisheries officers from the DOF Thailand and the TD staff. It is expected that the Database would complement the existing database and would be made applicable to small-scale fisheries data with appropriate statistics/indicators. The Database system would be designed and tested using a set of data collected from relevant activities in Krabi Province, Thailand as a pilot case.



Meeting on the Development of a Database System for Small-scale Fisheries on 27 April 2022 and 10 May 2022

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.

To follow up the surveys conducted in Krabi and Phang Nga Provinces, Thailand in 2021 with a total of 160 accomplished questionnaires, the result from the analysis was submitted to FAO in 2022. TD also submitted to FAO the “Project Narrative Report” and “Preliminary Report on the Investigation to Estimate the Abandon, Lost, and Discard Gillnet and Traps (pots) along the Coast of Thailand (Phang Nga and Krabi Province).” It is expected that through this project, the FAO questionnaire would be verified and finalized and support the information collection and development of management actions to eliminate marine debris from ALDFG in the future.

Regional Collaborative Research and Capacity Building for Monitoring and Reduction of Marine Debris from Fisheries in Southeast Asia

In April 2022, the project “Regional Collaborative Research and Capacity Building for Monitoring and Reduction of Marine Debris from Fisheries in Southeast Asia” was approved by the Japan-ASEAN Integration Fund (JAIF) to be implemented from 2022 to 2023. The overall objectives of Project are enhancing regional collaborative research and capacity building in the fisheries sector including the application of scientific knowledge of regional policies as well as monitoring the four priority areas of the “ASEAN Framework of Action on Marine Debris.” After the approval of the Project, TD coordinated with the JAIF project management to adjust the implementation plan and expenditure with no additional cost, and it is expected that the Project activities would commence in 2023.

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

The fisheries refugia approach has triggered a common interest in Southeast Asia as a good area-based management practice. The concept 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 is a hallmark. 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) improvement of 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. This Project, which was originally scheduled to be completed at the end of 2020, was extended until mid-2023 with technical closure by the end of 2022.



Regional Training Course on Larval Fish Identification and Fish Early Life History Science on 16–27 November 2022, Samut Prakan, Thailand

At national levels, the activities and outputs from six participating countries implemented in 2022 are as follows:

- **Cambodia:** Fisheries *refugia* sites in Kep and Koh Kong Provinces were under full operation including the creation of board management, patrolling, public awareness, and habitat restoration. For the site in Kampot Province, although the official boundary and proclamation have not been approved, some activities are being implemented including patrolling, information dissemination, habitat restoration, and strengthening of community fisheries. The development of national guidelines on the establishment and operation of fisheries *refugia* and reflection on an updated regional *refugia* action plan are ongoing and to be finalized by the country. Experiences in fisheries *refugia* establishment and management have been shared at national and provincial levels, as well as at the Faculty of Fisheries Science in the Royal University of Agriculture. Moreover, experiences and knowledge of fisheries *refugia* establishment and management in Kep and Kampot Provinces were shared with the Department of Fisheries of Thailand.
- **Indonesia:** The Agency of Marine and Fisheries Research and Human Resources of Indonesia produced several policy papers which contained the information required for the development of management plan based on the fisheries *refugia* concept. These papers were handed over to other two relevant agencies, *i.e.* Directorate

General of Capture Fisheries and Directorate General of Marine and Spatial Planning for further development of management plans and regulations regarding fisheries *refugia*. The policy briefs that were developed include: 1) Academic draft for establishing fisheries *refugia* management plan in West Kalimantan; 2) Academic draft for establishing fisheries *refugia* management of Bangka Belitung Province; 3) Policy brief of establishing fisheries *refugia* in West Kalimantan Province; and 4) Policy brief of establishing fisheries *refugia* in Bangka Belitung Province. In addition, all reports, data, and information including those on habitat characteristics, the GIS features for two fisheries *refugia* commodities were made available through <https://fisheries-refugia-indonesia.org/index.php/fisheriesrefugiadata/cumi-cumi> for squid and <https://fisheries-refugia-indonesia.org/index.php/fisheriesrefugiadata/udang> for shrimp.

- **Malaysia:** The Department of Fisheries Malaysia adopted the management strategy, especially for the closed season and control of minimum landing size of target species by the inclusion of additional clauses in the fishing licenses effective January 2023. The management plan and measures were accepted by stakeholders and endorsed by the government. Relevant information on the life cycles of mud spiny lobster and tiger prawn within the *refugia* site and appropriate public awareness materials are accessible through the national *refugia* website <https://devmarinepark.dof.gov.my/en/projects/refugia/>.
- **Philippines:** The National Fisheries Research and Development Institute (NFRDI) completed the national guidelines for establishing fisheries *refugia*, while three *refugia* sites agreed upon by stakeholders are on ongoing process to obtain approval by the local governments. Two technical papers were completed, namely: 1) Fish Eggs and Larvae composition, Abundance, and Distribution in the Three Fisheries *Refugia* sites in the Philippines, and 2) Landing and Distribution of Captured Fishes in Relation to the Establishment of Fisheries *Refugia* in the Philippines. The NFRDI also published “A Review of Philippine Approaches in Fisheries Conservation and Management and Developing a Policy Framework for Establishing *Refugia* in Key Fisheries Management Areas.”
- **Thailand:** Management plans for two *refugia* sites were endorsed by the Site-based Fisheries *Refugia* Management Board Meetings in Trat and Surat Thani Provinces in November 2022. National guidelines on establishing and operating fisheries *refugia* and National Action Plans for the management of priority fisheries *refugia* and associated biodiversity were endorsed and published. The dataset of national fisheries management, fishery biology of significant species in the Gulf of Thailand, fish stocks and habitats, fisheries statistics of Thailand, awareness materials, and others were published and made accessible at <https://inter.fisheries.go.th/fishrefugia>. In addition, datasets of fisheries management for the areas and periods of egg-bearing, spawning, and larval rearing of aquatic animals in some parts of the fishing grounds in the Gulf of Thailand were also accessible online.
- **Viet Nam:** The Directorate of Fisheries shared the experience notes “Establishment of Fisheries *Refugia* Towards Co-Management in Viet Nam.” This paper refers to the national development of the umbrella frameworks of fisheries *refugia* under national law, whereas 73 marine fisheries protection zones or *refugia* are planned for

2021–2030 with a total area of about 1,416,547 ha equivalent to about 1.5 % of the country’s sea area. Therefore, when the master plan is ready, it will be decentralized to the community through the co-management approach. The systems will engage multisectoral stakeholders in the implementation. At present, two of the 73 *refugia* sites were identified and accepted for further implementation by stakeholders, *i.e.* in the coastal area of Lagi in Binh Thuan Province of 73,900 ha for subcrenata ark and in the eastern coastal area of Phu Quoc in Kien Giang Province of 32,860 ha for blue swimming crab.

Furthermore, the Project also organized the “Regional Training Course on Larval Fish Identification and Fish Early Life History Science” on 16–27 November 2022 at TD in Samut Prakan, Thailand. With lecturers from universities in Thailand and Malaysia as well as scientists from TD and MFRDMD, the Training Course provided the knowledge and skill on larval fish identification and fish early life history science to fisheries scientists from eight AMSs, namely: Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Philippines, Thailand, and Viet Nam.

In 2022 as the last year of the Project implementation, the Project Coordination Unit (PCU) organized the “7th Meeting of the Regional Scientific and Technical Committee” on 8–10 November 2022 in Jakarta, Indonesia. Subsequently the “8th Meeting of the Project Steering Committee” was organized on 23 December 2022 through an online platform. The Project achievements including outputs and outcomes, and financial matters were monitored to assure that they are aligned with the results framework adopted by GEF. Several key outputs at the regional level such as the Regional Guidelines on Indicators for Sustainable Management of Fisheries *Refugia*, midterm review report, regional fisheries database, and dashboard were endorsed and published online via <https://fisheries-refugia.org>.



7th Meeting of the Regional Scientific and Technical Committee on 8–10 November 2022 in Jakarta, Indonesia



8th Meeting of the Project Steering Committee on 23 December 2022 via online

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

A total of fifteen (15) fisheries *refugia* sites of about 1,159,241 ha were identified and accepted by the relevant stakeholders. The area is approximately 4.3 times higher than the proposed *refugia* areas (269,500 ha) adopted by the GEF/CEO.

- Five fisheries *refugia* agreed upon among stakeholders and approved by the governments
 - Kep Province, Cambodia for blue swimming crab (11,307 ha)
 - Preah Sihanouk, Cambodia for blood cockle (116 ha)
 - Koh Kong Province, Cambodia for Indo-pacific mackerel (1,283 ha)
 - Surat Thani Province, Thailand for blue swimming crab (900 ha),
 - Trat Province, Thailand for Indo-pacific mackerel (154,600 ha).
- Eight (8) fisheries *refugia* sites recognized by the stakeholders and would be further adopted by the responsible agencies
 - Kampot Province, Cambodia for the juvenile grouper (284 ha)
 - Tanjung Leman, Johor State, Malaysia for spiny lobster (140,023 ha)
 - Kuala Baram, Miri, Sarawak State, Malaysia for black tiger prawn (55,600 ha)
 - Bolinao, Philippines for siganids (263 ha)
 - Masinloc, Philippines for one-stripe fusilier (624 ha)
 - Coron, Philippines for redbelly yellowtail fusilier (1,242 ha)
 - West Kalimantan, Indonesia for white prawn (409,432 ha)
 - Bangka Regency, Indonesia for squid (239,302 ha).
- Two fisheries *refugia* sites identified
 - Eastern coastal area of Phu Quoc, Kien Giang Province, Viet Nam for blue swimming crab (32,860 ha)
 - Lagi, Binh Thuan Province, Viet Nam for the *Subcrenata* ark clam (73,900 ha).

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 CoP-19 CITES held in Panama City, Panama in November 2022. The new species listed in Appendix II of CITES and their international trade consequently regulated include 104 species of sharks and rays, comprising 54 species of requiem sharks, six species of hammerhead sharks, 37 species of guitarfish, and seven species of freshwater stingrays. This brings up to 150 sharks and ray species listed on the Appendices of the CITES and represented almost 13 % of all known sharks and rays. Currently, almost one-third of all shark and ray species are believed to be threatened with extinction which were driven by overfishing.

While the species included in Appendix I of CITES are prohibited for all international commercial trade, the species listed in Appendix II are not necessarily now threatened with extinction, but that may become so unless trade is closely controlled. International trade may be authorized by granting an export permit or re-export certificate. Permits or certificates can only be issued if relevant authorities are satisfied that certain conditions are

met and that trade will not be detrimental to the survival of the species in the wild. Parties will have to use the tools of the Convention, such as Non-Detrimental Findings (NDFs) and legal acquisition findings for sustainability, legality, and traceability of the trade. 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 conservation and sustainable utilization. To enable the AMSs to accommodate such requirements, expertise in species identification and data collection on landings and sharks biology should be strengthened.

MFRDMD, therefore, implemented the Project “**Research for Enhancement of Sustainable Utilization and Management of Sharks and Rays in the Southeast Asian Region.**” The year 2022 was the third year of this Project which runs from 2020 to 2024. The Project was aimed at 1) developing capacity in taxonomy, including identification of new species/record and management of major shark species; 2) confirming the stock structures for at least two common species of sharks/rays and one CITES-listed species in participating countries (shared-stock or individual stocks); and 3) carrying out socioeconomic studies in northern Viet Nam, western Myanmar, and Indonesia.

In 2022, MFRDMD continued to provide capacity-building activities for relevant AMSs through the “Regional Training and Workshop on Chondrichthyan Taxonomy, Biology and Data Collection” held on 2–6 October 2022 in Kuala Terengganu, Malaysia. The Training participants were representatives from the AMSs, namely: Cambodia, Malaysia, Philippines, and Thailand, as well as staff from TD and MFRDMD. Lectures were provided on taxonomy, biology, preservation of specimens, data management, and standard operating procedure (SOP) for data collection up to the species level. For the practical sessions, the identification of common shark and ray species commonly found in coastal waters in the region, use of SOP for collecting tissue samples for DNA analysis, selection of samples at the landing site, and measurement technique of sharks and rays at landing sites were elaborated at the laboratory. The trainees also learned how to encode data into an Excel template and analyze the encoded data using the pivot table.



Regional Training and Workshop on Chondrichthyan Taxonomy, Biology and Data Collection on 2–6 October 2022 in Kuala Terengganu, Malaysia with the elasmobranch expert, Dr. Ahmad Ali, as lecturer (center in right photo)



Another study was undertaken by MFRDMD on “stock structure of selected species of sharks and rays by genetic markers.” This is considering that knowledge of stock structure is essential for the sustainable management of fisheries, and the pattern of stock structure could provide some indication of the spatial scales at which stocks should be viewed as the same or distinct fisheries management units. In this study, MFRDMD in collaboration with the DOF Sabah collected specimens of spot-tail shark (*Carcharhinus sorrah*), hammerhead shark (*Sphyrna lewini*), and sharpnose stingray (*Maculabatis gerrardi*) from two fish landing sites, *i.e.* SAFMA, Kota Kinabalu and Sandakan Wet Market in Sabah, Malaysia on 6–15 November 2022. The specimens would be utilized for the study of the stock structure of selected species of sharks and rays by the genetic marker. However, this study also affected the works undertaken by other two sampling sites in Malaysia, namely Kuantan in Pahang and Larut Matang in Perak. The sample collection at these sites was completed in 2021 except for *M. gerrardi* from Kuantan, Pahang as in September 2022 the plan for collection of *Chiloscyllium hasseltii* was changed to *M. gerrardi* due to the unavailability of *C. hasseltii* in Sabah.

The specimens for the stock structure study were brought back to MFRDMD and stored in the DNA Laboratory for further analysis. The study uses the mitochondrial DNA D-loop region. The necessary tools and kits were purchased, and the DNA analysis of the samples collected is in progress.



Collection of shark and ray specimens for the DNA analysis

MFRDMD also supported landing data collection on sharks and rays by species in Malaysia at landing sites in Kota Kinabalu and Tawau in Sabah from January to December 2022. The objective of this study is to collect landing data and biology information on sharks and rays by species. Data were collected at least 12 days every month from up to three vessels randomly selected on each day at the landing site. All sharks and rays were measured and weighed individually if the total number was less than 50 individuals per vessel. Whilst, a sub-sample of about 10–50 % was measured if the total number was more than 50 individuals. The results showed that the landings of sharks and rays at Kota Kinabalu were higher than at Tawau. For Kota Kinabalu, there were 19 species of sharks with a catch composition of 0.25 % (5,066.8 kg) and 23 species of rays with a catch composition of 0.72 % (14,886.8 kg). For Tawau, there were only two species of sharks with a catch composition of 0.14 % (233.5 kg) and seven species of rays with a catch composition of 0.77 % (1,352.7 kg). It should be noted that although *Sphyrna lewini* and *Carcharhinus sorrah* are listed in CITES, the species are among the dominant species recorded in both Kota Kinabalu and Tawau.

Table 1. Landing data on sharks and rays in Kota Kinabalu and Tawau

Group	Kota Kinabalu		Tawau	
	Sharks	Rays	Sharks	Rays
Number of species	19	23	2	8
Total weight (kg)	5,066.8	14,886.8	233.5	1,352.7
Catch composition (%)	0.25	0.72	0.14	0.77
Dominant species	<i>Chiloscyllium punctatum</i> , <i>Carcharhinus sorrah</i> , <i>Chiloscyllium plagiosum</i> , <i>Alopias pelagicus</i> , <i>Sphyrna lewini</i> , <i>Carcharhinus brevipinna</i>	<i>Neotrygon orientalis</i> , <i>Telatrygon zugei</i> , <i>Maculabatis gerrardi</i> , <i>Rhinoptera jayakari</i> , <i>Pateobatis jenkinsii</i>	<i>Sphyrna lewini</i> , <i>Carcharhinus sorrah</i>	<i>Maculabatis gerrardi</i> , <i>Gymnura zonura</i> , <i>Neotrygon orientalis</i> , <i>Taeniura lymma</i>



Weighing of ray (left) and measuring of shark (right) at the landing site

Under this Project, MFRDMD in collaboration with the DOF Malaysia also conducted a pilot activity on nursery ground surveys for sharks and rays in Pahang located on the east coast of Peninsular Malaysia. The surveys were undertaken during the first, third, and fourth quarters of 2022; and it is expected that the result from this activity would be published as a technical report of MFRDMD in 2023.

In addition, MFRDMD in collaboration with WWF-Malaysia and University Malaysia Terengganu (UMT) organized the “Workshop on Taxonomy, Creel and Genetic of Sharks and Rays” on 7–10 March 2022 at MFRDMD. The Workshop was attended by a total of 14 participants from WWF-Malaysia, UMT, and MFRDMD.



Participants of the Workshop on Taxonomy, Creel and Genetic of Sharks and Rays on 7–10 March 2022

Conservation and management of catadromous eels

The need for the promotion of sustainable management and utilization of catadromous (anguillid) eel resources has widely been recognized in the Southeast Asian region in response to the increased market value of tropical eels during the recent years. Toward this, SEAFDEC carried out two regional projects, namely: “Sustainable Utilization of Anguillid Eels in the Southeast Asia Region” and “Development of Stock Assessment Methods and Strengthening of Resources Management Measures for Tropical Anguillid Eel in Southeast Asia.”

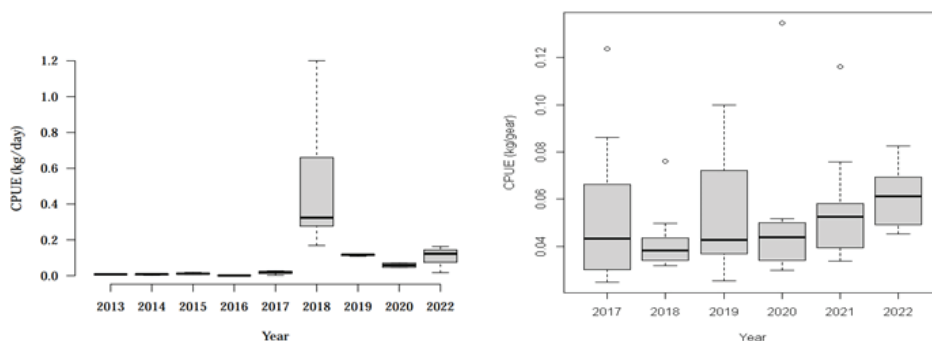
The project “**Sustainable Utilization of Anguillid Eels in the Southeast Asian Region**” is being implemented by SEAFDEC/IFRDMD from 2020 to 2024 and with the goals to obtain a better understanding of the status, biology, and life cycle of anguillid eel stocks and to promote sustainable management and utilization of the eel fishery resources in the region. The Project activities were aimed at standardizing the data collection system and clarifying the Southeast Asian eel genetic population structure. It should be recognized that information on genetic population structure or stocks is essential for fisheries management as it can help identify the source and sink populations and the potential for replenishing the depleted stocks. Moreover, molecular genetic techniques have been widely used in marine systems and fisheries management due to the ability to identify distinct stocks, genetic health, and connectivity between stocks.

During 2020–2021, there was no market demand for anguillid eels in the region due to the COVID-19 pandemic which adversely impacted eel fishery activities. However, in 2022, the activities recommenced and IFRDMD continued to collect the catch data, specifically the CPUE of anguillid eel fisheries in Cilacap and Palabuhan Ratu in Indonesia and Cagayan and General Santos in the Philippines.

For Indonesia, Palabuhan Ratu is the main fishing ground for *Anguilla bicolor bicolor*. The data on glass eel catch which has been collected in this area since 2013 was continued until 2022. The data showed fluctuation in glass eel catch in Palabuhan Ratu with a generally decreasing trend from 2013 to 2022. The lowest glass eel catch was recorded during the period from 2020 to 2021 due to the COVID-19 pandemic that affected the market demand for glass eels. The market demand resumed in late 2021 until 2022 when the COVID-19

situation has improved. From glass eel CPUE standardization using generalized linear model (GLM) with gamma, the result showed that the most accounted variables are by the year. The month and quarter have a less significant effect on the catch than the year.

Moreover, Cilacap, Indonesia is the only eel fishing ground that was not affected by the COVID-19 pandemic. It is the location for the collection of data on elvers and yellow eels with *A. bicolor bicolor* as the dominant species. The nominal CPUE of elvers in Cilacap which was steadily flat from 2017 to 2020 extremely increased in 2022. The result from elver CPUE standardization using GLM with gamma showed no significant effect on the month, quarter, and year in Cilacap.



Annual CPUE nominal series (kg/day) of eels in Indonesia: glass eels in Palabuhan Ratu (left) and elvers in Cilacap (right)

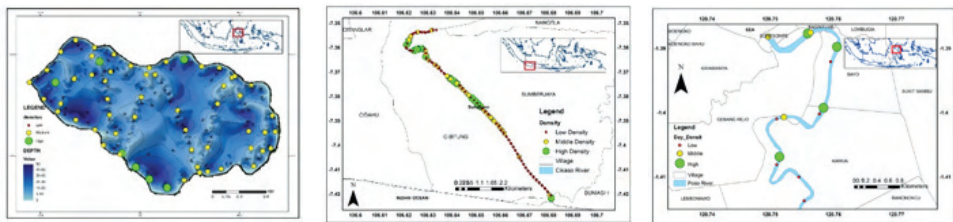
In the Philippines, an eel farm was closed during the COVID-19 pandemic and there was no demand for glass eels. In 2022, when the COVID-19 situation gradually improved, fishers started collecting data on glass eels as well as additional data on adult eels. The primary data sources were from the northern part of the country in Cagayan City and southern part in General Santos and Cotabato City. It was found that although *A. marmorata* is the dominant species in the Philippines, *A. bicolor pacifica* was more exploited due to its high price in the southern area of the country. From the data collected by IFRDMD since 2016, the results showed the fluctuation of catch data and CPUE of glass eels in the Philippines from 2016 to 2022. As for fishers, the number of fishers decreased from 2016 to 2021 but started to increase in 2022.

As for the collection of biological data, the survey was conducted in General Santos and Cotabato City in the Philippines after the COVID-19 situation improved. During the pandemic, there was no demand ceasing the activities until May 2022 when the consolidator started collecting glass eels again. Fishers learned from the Japanese expert how to separate the species of glass eels, *i.e.* between *A. bicolor* and *A. marmorata*. The price of glass eels is approximately USD 54/kg (PHP 3,000/kg). For *A. bicolor*, one kilogram of glass eels comprises approximately 7,800 individuals; while for *A. marmorata*, one kilogram comprises approximately 6,800 individuals. The fishing season for yellow eels is usually in December.



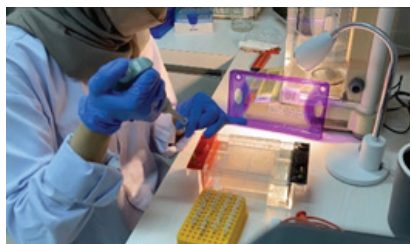
Biological survey in General Santos City and Cotabato City in the Philippines: interview with a collector (left), interview with the fisher (center), and glass eel fishing (right)

In 2022, IFRDMD continued to explore other stock assessment method for calculating the status of Anguillid eel. Besides the CPUE data, the acoustic survey is another approach to assess the fish stock. IFRDMD, therefore, conducted a hydroacoustic study in Indonesia with activities, *i.e.* target strength (T.S.) measurement and tracking survey to assess and analyze the characteristics of the T.S. of anguillid eel and calculate eel density by using hydroacoustic equipment. The acoustic surveys were undertaken by IFRDMD in the Cikaso River in West Java, Rano Lake in Central Sulawesi, and Poso River in Central Sulawesi. A hydroacoustic transducer was attached to the side of the vessel. The tracking path was in the horizontal side view, while the vessel speed was set at 3.8 kn. T.S. measurement was conducted by placing the anguillid eel in the cage and recording the return echo before measurement, then morphological parameters of the fish such as length and weight were recorded. The result from this survey showed the number of fish detected and a map of the spatial distribution of anguillid eel in Cikaso River, Poso River, and Rano Lake.

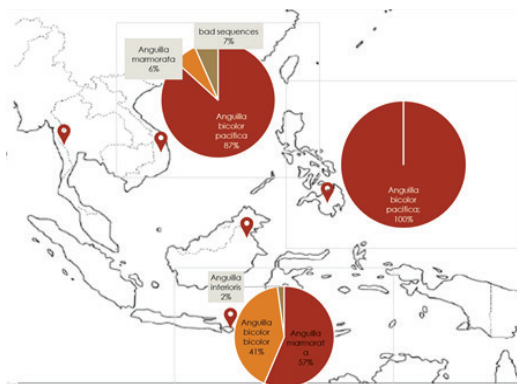


Spatial distribution of anguillid eels in Indonesia: Rano Lake in Central Sulawesi (left), Cikaso River in West Java (center), and Poso River Central Sulawesi (right)

For the genetic study, IFRDMD analyzed tissue samples of tropical anguillid eels collected from selected Southeast Asian countries in 2022. The samples were collected from Bali and Kalimantan Provinces in Indonesia, General Santos City in the Philippines, and Phuyen Province in Viet Nam. Although the COVID-19 pandemic affected the sample collection process, data analysis was carried out to obtain information on the genetic diversity and population structure of the *A. marmorata*. In 2022, a total of 106 samples were sequenced using the Zymo kit. The samples from Bali, Indonesia consisted of *A. marmorata* (57 %), *A. bicolor bicolor* (41 %), and *A. interioris* (2 %). All samples from the Philippines were *A. bicolor pacifica*. The samples from Viet Nam consisted of *A. bicolor pacifica* (87 %) and *A. marmorata* (6 %), while 7 % of the samples were not fit sequencing.



Genetic study on anguillid eels: Agarose gel electrophoresis (above) and percentage of samples of anguillid eel species collected from Indonesia, Philippines, and Viet Nam (right)



The Project also integrated gender in analyzing the anguillid eel value chain. It was found that most of the anguillid eel consolidators and collectors in some Southeast Asian countries are women, and they also served as enumerators to support data collection for this Project. As an example, in Denpasar, Bali, women are involved in the eel fishery as collectors and play important role in connecting fishers and buyers as well as in setting the retail price of the fish. Therefore, the Project intended to strengthen the roles and empower women in relevant aspects.



Gender analysis in anguillid eel value chain: eel collectors are mostly women in Indonesia (left and center) and in the Philippines (right)

The other 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 AQD and IFRDMD. 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 expected to extend until January 2024. The Project aims to collect the catch data and biological/ecological information for the estimation of the abundance of eel stocks, develop mathematical/statistical methods for estimating tropical anguillid eel stocks, and formulate effective management measures on tropical anguillid eel resources in Southeast Asia. Under this Project, four main activities have been carried out since 2020, namely: 1) eel statistics survey, 2) eel catch survey, 3) genetic study, and 4) environmental DNA study.

In 2022, under the activity on eel statistics survey, data and information on capture fishery and/or aquaculture of anguillid eels were collected from selected sites in Indonesia,

Myanmar, and Philippines. For Indonesia, eel catch surveys were conducted in Cimandiri River and Cikaso River in Palabuhan Ratu of Sukabumi Regency and Poso River in Central Sulawesi since April 2020 and would be continued until December 2023. For Myanmar, eel catch surveys were conducted in Ayeyarwady Region and in Yangon City from April to October 2022. For the Philippines, eel catch and aquaculture surveys were conducted in Abulug and Appari Municipalities in Luzon Island and in Cotabato City and General Santos City in Mindanao Island from February to September 2022.



Project sites in Indonesia, Myanmar, and Philippines for eel catch surveys

For the eel catch survey, the catch per unit effort (CPUE) would be analyzed to obtain an understanding of the trends of eel resources and support stock assessment. The trial analysis was conducted to determine the appropriate model to be used by using the data from the Poso River in Indonesia for yellow eel and Cagayan River in the Philippines for glass eel which were collected during the previous JTF project on anguillid eels. Once the data and information are completely obtained from the Project sites, it is envisaged that catch and effort data, standardization of CPUE, habitat suitability analysis, and population dynamics models could be developed by making a simple simulation to evaluate the catch trends in the future.



Eel catch survey in Indonesia using scoop net from Palabuhan Ratu (left) and rattan trap from Poso (right)

For the genetic study, the aim was to identify the genetic population structure of *Anguilla bicolor pacifica* and *A. bicolor bicolor* using different markers, e.g. COI, Cyt-B, D-loop region, and microsatellite. After the completion of DNA analysis using COI marker in 2020 from a total of 118 samples (58 samples from Indonesia, 30 from the Philippines, and 30 from Viet Nam), the BLAST results showed that all of the samples were identified as *A. bicolor pacifica*. To accurately determine the genetic population of all samples, however, analysis using different genetic markers was necessary. Thus, an analysis using the Cyt-B marker was conducted in the laboratory. In 2022, IFRDMD successfully analyzed a total of 174 samples (50 samples from Indonesia, 30 from the Philippines, and 94 from Viet Nam) by using the Cyt-B marker. However, more samples from different locations using Cyt-B marker are still needed. Meanwhile, the development of protocols for eel tissue collection for genetic research is in progress.

For the environmental DNA (eDNA) study, AQD conducted 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 objectives of the study were to define spatial and temporal variation in *A. bicolor* populations and determine the utility of eDNA analysis as a non-invasive tool. In 2022, four surveys were conducted using water samples collected from the Cagayan River, Bicol Region, and Bantilan River in Sariaya, Quezon in the Philippines for DNA extraction. However, it was found that the collected water samples were not enough for DNA extraction. Thus, the volume of water samples was increased and a filter with finer pores was used. Finally, AQD successfully optimized the sampling and eDNA analysis protocol. The expected deliverables from this activity are two publications, namely: 1) Environment DNA Survey Manual: Water Sampling and eDNA Assay for Tropical Eels in Southeast Asia and 2) A Manual on the Identification of Tropical Anguillid Eel Species using Visual and/or DNA-based Methods, and a video on sample collection, e-DNA extraction, and amplification, which would be finalized and disseminated in 2023.



DNA extraction from water samples to determine the pattern of eel distribution in Southeast Asia

1.8 Capacity building towards sustainable fisheries

Promotion on Strengthening of SEAFDEC Visibility and Enhancing Human Capacity Building

In 2022, SEAFDEC/TD continued the implementation of the ongoing program “**Promotion on Strengthening of SEAFDEC Visibility and Enhancing Human Capacity Building**” by publishing relevant information through various channels and organizing two exhibitions. Thirty-one articles on fisheries management, fishing technology, combating IUU fishing, and fishery resources were disseminated to the public through TD website and Facebook page. Moreover, four videos were produced and published on TD YouTube channel.



SEAFDEC participates in Thailand Fishery “Pramong Nomkiao” Exhibition on 1–10 July 2022 in Thailand



SEAFDEC joined the 7th Marine Science Conference on 5–7 September 2022 in Bangkok, Thailand

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 2022, 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:

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

Enterocytozoon hepatopenaei (EHP) is an emerging microsporidian parasite that invades the tubule epithelial cells of the hepatopancreas of cultured shrimp which causes growth retardation. Given its emerging importance and potential spread which particularly makes harmful impacts on the shrimp industry, studies on EHP are urgently needed. Thus, the study surveyed the epidemiological information on the distribution, occurrence, and

prevalence of EHP as well as observed the transmission mechanism of EHP in shrimps. Subsequently, the information gathered from the research would be compiled as guidelines and management measures against EHP.

In 2021, an active surveillance of EHP was conducted in the Philippines within the Iloilo Province during wet (December–May) and dry (June–November) seasons in shrimp farms. However, due to the COVID-19 pandemic, travel restrictions were implemented thus, sample collection onsite from various shrimp farms was hindered. Alternatively, shrimp samples already received by AQD Fish Health Laboratory from different hatcheries were analyzed for the presence of EHP. The parasite was detected through wet smear, Nested-Polymerase Chain Reaction (PCR), and histological analysis. Three farms and three hatcheries were investigated for EHP with a total of 1,078 shrimp samples analyzed, 51 % were *Penaeus monodon* and 49 % were *P. vannamei*. Nested-PCR results showed that two farms, Ajuy, Iloilo (Farm 1) and Dumangas, Iloilo (Farm 4), were positive for EHP. Moreover, the overall EHP prevalence in hatchery-reared and grow-out shrimp was 0 % and 11.3 %, respectively. Out of the four farms, only Farm 3 in Zarraga and Farm 4 in Dumangas were sampled for pond soil during harvest, and PCR analysis showed negative results for EHP.

The survey was continued in 2022. A total of 1,302 shrimp samples were analyzed, 64.7 % were *P. vannamei* and 35.3 % were *P. monodon*. Seven farms and three hatcheries were assessed for the presence of EHP. Three farms were located in Zambales, Philippines, while the rest of the farms and hatcheries were located in the Visayas region. In Nested-PCR analysis, EHP was detected in three farms including Farm 2 in Ajuy, Farm 3 in Dumangas, and Farm 6 in Masinloc, Zambales. On the other hand, all hatcheries were negative for EHP. The overall prevalence of EHP in hatchery-reared and grow-out shrimp was 0.0 % and 5.3 %, respectively.

In 2021 and 2022, microsporidian parasites were undetectable through wet mount analysis whereas histological analysis of PCR-positive samples is still ongoing.

The prevalence of EHP showed variation in the dry and wet seasons. In 2021, EHP was detected during wet and dry seasons, particularly in January and February with 32 % and 27 % prevalence, respectively. Moreover, it was also present during the dry season in September with 23 % prevalence. In 2022, EHP was only detected during the dry season with a prevalence ranging from 2 % to 100 % peaking in September.

Managing viral and other emerging diseases in brackishwater ponds

In shrimp aquaculture, the success of the farming operation is highly dependent on the growth and survival of the farmed species, which is determined by the occurrence or non-occurrence of disease outbreaks. Many strategies, in varying combinations, were tried and tested in many fish farms to reduce the incidence of diseases spreading in aquaculture facilities. This study aims to test a combination of disease management approaches, such as the use of immunostimulants, probiotics and antivirals, biosecurity, and best management practices for culturing *Litopenaeus vannamei* (whiteleg shrimp) in brackishwater ponds.

In 2022, the approaches, including disinfection of pond soil and water and using postlarvae from specific pathogen-free broodstocks, were tested.

To simulate pond conditions, two types of trial tanks (disinfected and non-disinfected) were prepared to test the effectiveness of the pond management strategies against the white spot syndrome virus (WSSV). The soil collected from AQD Dumangas Brackishwater Station was subjected to quantitative polymerase chain reaction (qPCR) analysis to check the presence of the pathogen. Subsequently, the shrimp postlarvae (PL) used in the disinfected tank were also tested by qPCR after applying stress to ensure that pathogen loads, if present, increase to detectable levels. The PL that gained negative results in qPCR were stocked in the disinfected trial tank. Meanwhile, soil, water, and PL used in the opposing trial tanks were made sure to get infected by WSSV through deliberate inoculation of the target pathogen to the trial. A control tank was also prepared, stocked with PL from non-SPF broodstocks, and analyzed using conventional PCR without undergoing stress exposure. All steps considered part of the best management practices were included as standard operating procedures and applied similarly to all treatments. A commercial probiotic was used applying the recommended protocol of the manufacturer. Shrimps were sampled during the culture to monitor their growth and development (weight, length, and survival) starting on day 30 and every after 15 days. Routine PCR analysis was also conducted to ensure that the stocks remained negative for WSSV and other pathogens. After 60 days of culture, results showed that PL from SPF broodstocks stocked in well-prepared and disinfected tanks grew (2.73 g in weight and 7.98 mm in length) and survived (68.5 % survival rate) than those in non-disinfected ponds (2.29 g in weight, 7.57 mm in length, and 61.5 % survival rate). To continue this study, another trial is underway to implement new disinfection protocols using 40 ppm chlorine for seven days and to dry to 5.0 % soil moisture.

Developing diagnostic procedures against crustacean and fish diseases

Viral and bacterial diseases have caused significant constraints in fish and shrimp farming. The need to develop disease diagnostic protocols for unknown and emerging diseases is the most efficient response to implement immediate and appropriate interventions to prevent and control the infection. In 2022, the Project will focus on monitoring and surveillance of mass mortalities in aquaculture caused by unknown and emerging crustacean and fish diseases. This will enable the isolation and identification of the causative agents and the development of disease diagnostic protocols in the country.

In 2020 and 2021, the Project studied three farms in the Philippines that experienced mass mortalities, including mangrove crab grow-out farms in Pontevedra and Panay in Capiz Province and a shrimp grow-out farm in Ajuy, Iloilo. The prevalent bacterial isolates from the samples were identified and stored in a -80 °C freezer for artificial infection trials to identify pathogenic isolates. For 2022, the monitoring and surveillance of mass mortalities in the aquaculture field continued.

A grow-out farm for *L. vannamei* in Zarraga, Iloilo reported mass mortalities at 32 days of culture. The farm had two ponds with an average area of 7,500 m² and a stocking density of 70–80 pieces/m². Following a PCR analysis, the cultured shrimp tested positive for WSSV despite the implementation of strict biosecurity protocols and good aquaculture practices. In response, close PCR monitoring was conducted. For bacteriological analysis, the total plate counts of the rearing water and hepatopancreas from the ponds were significantly high (10⁴–10⁶). This may be due to the addition of probiotics in the rearing water and inclusion in feeds. Meanwhile, luminous bacteria count (LBC) was 0, and presumptive

vibrio counts were 10^3 – 10^5 (the threshold level in shrimp is 10^4). For the molecular analysis, despite the farm's proactive monitoring for WSSV and acute hepatopancreatic necrosis disease (AHPND), one of the ponds tested positive for WSSV at DOC 32 following a PCR analysis. Interventions such as providing probiotics and additional immunostimulants were implemented. Following that, the ponds tested negative for both WSSV and AHPND throughout the culture period, and the farm successfully harvested the stock.

Another *Penaeus monodon* grow-out farm in Dumangas, Iloilo was also monitored. The three ponds with areas of 5,000–8,000 m² had a stocking density of 15–20 pieces/m². The farm observed strict biosecurity and good aquaculture practices, similar to the farm mentioned above located in Zarraga. Samples were collected from the animal and rearing water and processed at AQD Fish Health Laboratory in Tigbauan, Iloilo. Results showed that the total plate counts of the rearing water and hepatopancreas from the three ponds were sufficiently high (10^3 – 10^5). This may be due to the addition of probiotics in the rearing water and inclusion in feeds. Meanwhile, luminous bacteria were at 10^1 – 10^2 , and presumptive vibrio counts were at 10^3 – 10^4 (the threshold level in shrimp is 10^4). Fifty-three isolates were identified in the first batch. The results showed that the most prevalent bacterial species from the shrimp samples were *Vibrio mytilii* (7 %), *Serratia fonticola* (7 %), *V. hispanicus* (7 %), and *V. mimicus* (7 %), while in water samples were *V. mytilii* (13 %), *V. furnisii* (8 %), *Moroccus sp.* (8 %), *V. diazotrophicus* (8 %), and *V. hispanicus* (8 %). The biochemical identification of the remaining isolates is still ongoing. During the culture period, the animals from all ponds were negative for the two target pathogens, WSSV and AHPND.

For the remaining time of the study, the development and optimization of disease diagnostic protocols for two important and emerging diseases, including Decapod Iridescent Virus (DIV1) and Mud Crab Reovirus (MRCV) were added.

Ecosystem approach to responsible and sustainable shrimp farming

Clustering or zoning is an ecosystem approach that would help minimize and mitigate the risk of disease by sharing the same water source and having the same inlet and outlet in aquaculture systems. In this study, an artificial or constructed wetland was designed using identified aquatic organisms to investigate the feasibility of aquaculture clustering or zoning in the Philippines.

The mesocosm experiment, with the best organisms for wastewater purification, started in 2021 using a recirculating aquaculture system to simulate an artificial or constructed wetland and was completed in 2022.

To refresh, the experiment consisted four interconnected tanks with three compartments. The first compartment (C1) was used to culture shrimp, while the second compartment (C2) served as a reservoir that received 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.

After four replications of the experiment, results showed no significant difference in observed shrimp survival rate, weight gain, and carapace lengths when using either

Holothuria, *Caulerpa*, or *Gracilaria*. However, shrimp cultured in *Holothuria*-treated water gained the highest survival rate (60.00 ± 16.32 %). Meanwhile, weight gain (87.20 ± 105.67 %), increase in carapace (23.07 ± 25.14 %), and total length (21.59 ± 20.97 %) were highest in *Caulerpa*-treated water.

In terms of mitigating diseases, shrimp bacterial profiles were analyzed. Results showed that the total heterotrophic bacterial count (TPC), which includes both beneficial and harmful bacteria, was highest in shrimps cultured using *Holothuria*-treated water. Meanwhile, luminous bacteria were not detected in shrimp cultured with *Gracilaria*, but were highest in shrimp in control tanks. The percentage of *Vibrio parahaemolyticus* (%Vp) was the lowest in shrimp cultured in *Holothuria*-treated water and the highest in the control tank. Percentage of *Vibrio cholera* (%Vc) was highest in control shrimp, and none were recovered in shrimp cultured with *Holothuria* and *Gracilaria*. Percentage of *Vibrio alginolyticus* (%Va) was highest in shrimp cultured in *Holothuria*-treated water and was lowest in control shrimp. Notably, luminous bacteria, *V. parahaemolyticus*, and *V. cholera* were implicated in several shrimp mortality cases. Meanwhile, some *V. alginolyticus* have probiotic effects. Overall, there was no significant difference in the three organisms in terms of shrimp bacterial profile.

Average nutrient levels in different tanks stocked with the different organisms (C3) and those stocked with shrimp (C1) were observed over time. In C3, ammonia, phosphate, and TAN were not significantly lowest in tanks with *Caulerpa* and *Gracilaria* but were highest in the control or untreated water. In C1, ammonia, phosphate, and TAN were not significantly lowest in tanks with *Gracilaria*-treated water and generally highest in control tanks or those that used untreated water.

Observed TPC, LBC, percentage green *Vibrios* (%gV), and %Va were not significantly different. A significantly lower %Vp was observed in tanks with *Caulerpa* and in the control. Significantly higher *V. cholera* was observed in tanks with *Caulerpa*. Subsequently, the bacterial profile observed in tanks using treated water and the control were not significantly different.

All organisms decreased in weight. The lowest weight loss was observed in *Holothuria* (-7.35 %), followed by *Gracilaria* (-9.51 %). The most significant decrease in weight was observed in *Caulerpa* (-37.89 %).

After the completion of the experiment, the mesocosm system efficiency will be verified in small-scale shrimp farms. In 2023, sites will be selected and collaborators will be identified.

Investigation of organisms, disinfectants/chemicals, and methods to prevent transmission of shrimp diseases

Diseases have caused setbacks in black tiger shrimp (*P. monodon*) for years. This study had been identifying and examining various chemicals and methods that can disinfect the fertilized eggs and nauplii of shrimp against pathogens. In particular, electrolysis, benzalkonium chloride, sodium hypochlorite, sodium chloride, treflan, and laundry detergent are being tested as disinfectants. Egg disinfection studies had been conducted previously but the efficiency of the aforementioned disinfectants in eliminating recent pathogens has not been verified.

Two runs of egg disinfection using three concentrations (50 ppm, 100 ppm, and 200 ppm) of formalin, hydrogen peroxide, and detergent with four replicates per treatment were done. Disinfected eggs were allowed to hatch and cultured until the postlarvae stage. Results showed significant differences in the hatching rate of the eggs disinfected with the different concentrations of the disinfectant and the control. The lowest hatching rate was observed in eggs disinfected with hydrogen peroxide which were also significantly lower than the control. Meanwhile, the percentage of nauplii that developed into mysis and from mysis to postlarvae were not significant between treatments including the control. Although, lower percentages of nauplii that developed into mysis and from mysis to postlarvae were observed in those disinfected with hydrogen peroxide.

In addition, three batches of undisinfected and disinfected eggs from three spawners were submitted for disease diagnosis. Results showed that the WSSV and infectious hypodermal and hematopoietic necrosis virus (IHHNV) load of disinfected eggs, including the control, were not significantly different. This implied that detergent, hydrogen peroxide, and formalin with concentrations as high as 200 ppm were not effective against the aforementioned pathogens. Increasing the concentration may not also be advisable due to the possible effect on the hatching rate and overall development of the shrimp.

As for the nauplii stage, two batches were disinfected using three concentrations (50 ppm, 100 ppm, and 4,200 ppm) of formalin, hydrogen peroxide, and detergent were done. AHPND was not detected in all treatments including the control. Results implied that the AHPND may be removed from the shrimp nauplii through rinsing with running UV-sterilized seawater. However, more replicates should be done to be conclusive. The results of the study would be used in in developing recommendations and guidelines on how to prevent shrimp disease transmission at the hatchery phase.

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 the creation of new local aquaculture industries.

- *Slipper lobster*

The scyllarid lobster (*Thenus orientalis*) is one of the five species commonly traded in the Philippines. It is sought after as a seafood delicacy with a reasonable 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.

The collection of adult slipper lobsters from the wild continues as the study aims to develop an efficient transport protocol. The importance of acclimatization prior to stocking in tanks was highlighted in the study. In 2022, modifications were implemented to improve the protocols developed last year and to ensure high survival. New protocols include transporting only gravid females with eggs to reduce the number of animals during transport and collecting slipper lobsters only during the season (July–November).

As for the hatching activities, it was observed that egg coloration has been a helpful factor in identifying the stage of embryonic development. Fertilized eggs are dark yellow or orange in color, while pre-hatching egg mass turned brown in color due to the eye pigment of the embryo and reduced yolk. Eggs spawned by slipper lobsters stocked at AQD hatcheries continued to hatch. After the hatching, the phyllosomas were stocked in 1-ton fiberglass tanks for observation. No mortality was observed after the females hatched their eggs.

A feeding study was also conducted in 2022 to maintain the broodstocks in captivity. Feeding of adult slipper lobsters was tested using frozen mussel meat, frozen squid, and frozen flesh of fish. It was observed that the slipper lobsters were actively feeding on fish and squid, and would ignore the mussels when offered via a rotational feeding schedule. When available, *Acetes* and small silver fish locally known as “*lobo-lobo*” or “*dulong*” were also offered as feed. It was observed that the slipper lobster would prefer the *lobo-lobo* and squid compared to *Acetes* and mussels. This part of the study will continue to determine the growth of the slipper lobster in total length and body weight.

Initial trials were conducted to determine the appropriate culture vessel for the phyllosomas. Currently, 12-liter capacity plastic pails were used and preferred due to easy maintenance. The stocking density was kept at 5 larvae/L. It was noted that mild aeration was important to keep the phyllosoma actively moving and suspended in the water column. UV-treated water was also used as rearing water. It was observed that mass mortalities of the phyllosomas occurred when the water temperature decreased to 25–26 °C from the ambient 27–29 °C due to the prolonged rainy season. Thus, the installation of a water heater will be critical for the survival of the phyllosomas. *Brachionus*, *Artemia nauplii*, and *Nanochlorum* sp. were offered as the first food for the phyllosomas, but results need to be further verified.

- *Kawakawa*

The study of generating basic information on the possibility of the culture of kawakawa (*Euthynnus affinis*), one of the neritic tunas that are economically important in Southeast Asia, continued in 2022. To establish and understand the timing when kawakawa appears in a particular location, it was decided to source the samples only from otoshi-ami or set-net where location is already known. In 2022, 338 kawakawa were collected from January to December, except for April and September when samples were unavailable. The collected samples include 45 females, 55 males, and 238 undetermined due to undifferentiated gonads. Mature and juveniles can be collected monthly, albeit some samples were unavailable due to typhoons causing strong water currents and waves impeding hauling operations.

The gonadosomatic index (GSI) of the samples was observed as part of the reproductive biology aspect of the research. The highest GSI was observed in June for females and August for males; however, data still needs to be more conclusive due to the insufficient number of samples. Interestingly, the reproductive activity showed that the spawning-capable stage was observed in June for females and August for males, in synchrony with the month with the highest GSI. Despite the low correlation due to an insufficient number of samples, it was observed that the fish size was directly proportional to the GSI, fecundity, and oocyte diameter.

Kawakawa samples were dissected and stomachs were examined for gut content analysis. Based on food composition, mature and larger-sized kawakawa were found to be highly piscivorous consuming mostly fish (anchovy, barracuda, and fish carcass) and some squid and crab megalopae. The index of relative importance indicated that fish is the most important diet of kawakawa. On the other hand, juveniles preferred smaller fish, *Acetes*, shrimps, anchovies, and water striders.

Handling trials were carried out for the collection and transport of kawakawa from the otoshi-ami of Barbaza Multipurpose Cooperative to AQD Tigbauan Main Station in January, February, March, and June 2022. Kawakawa was first conditioned to a small impoundment to let them adjust to a small environment before they were subjected to transport. The fish were temporarily stocked in 2 m × 2 m × 2 m cage and later to a larger size 5 m × 5 m × 3 m cage with fine mesh netting and PVC frames for 3–4 days before transport and were fed anchovy fries while being maintained in the temporary cage. Using a scoop net with 150 µm mesh, juveniles were scooped out from the cage and were packed and oxygenated in 40 in × 40 in transport bag at 2–5 fish/bag with 15 L of seawater. Fish were then stocked in 800 L customized transport tank containing 500 L of UV-treated seawater with 0.05g/L sodium nifurstyrenate at a maximum stocking density of 12 fish per tank. Water temperature in the transport tank was maintained at 25.4–25.8 °C for three hours and a 100 % survival rate was achieved. Size was a significant factor to consider during handling and transport. Survival rate showed that smaller sizes were better to handle and transport compared to bigger size kawakawa.

In terms of tank management, kawakawa were maintained in 10-ton tanks covered with B-net and fed fresh or thawed squid and chopped raw fish to satiation level daily. Fish were kept in a seawater flow-through system with aeration. Regular draining and replenishment (50–60 %) of seawater were carried out to prevent algal bloom. Water parameters were monitored daily with ranges as follows: temperature (25.97–30.3 °C), salinity (32.0–34.4 ppt), dissolved oxygen (5.8–6.8 mg/L), and pH (7.8–8.3). Though the said water parameters were maintained, mortality still occurred because of ammonia levels that were higher (0.25–0.5 ppm) compared with the levels indicated for the optimum condition for other marine fish species (< 0.02 ppm). Preventive measures employing the use of UV-treated seawater somehow addressed water quality issues; however, mortality still occurred because of intermittent power interruption disrupting aeration and turbid water during the rainy season. Mortalities were submitted to the Fish Health Laboratory and results showed negative for parasites. Experiments to improve transport protocols, broodstock management, nutrition, and disease monitoring will be conducted in 2023.

While several difficulties were encountered in maintaining kawakawa in captivity, most managed to grow until maturity. The mature size was obtained at eight months for female (*figure (A)*) at 800 g with a 0.6 GSI and 10 months for male (*figure (B)*) at 1,750 g with a 0.7 GSI. Through histological analysis of gonads, their reproductive stage shows that a female is still classified as immature while the male is still in the developing stage. Mortalities were submitted to the Fish Health Laboratory and results showed negative for parasites. Experiments to improve transport protocols, broodstock management, nutrition, and disease monitoring will be conducted in 2023.



(A) Wild female kawakawa that mature in captivity for 8 months



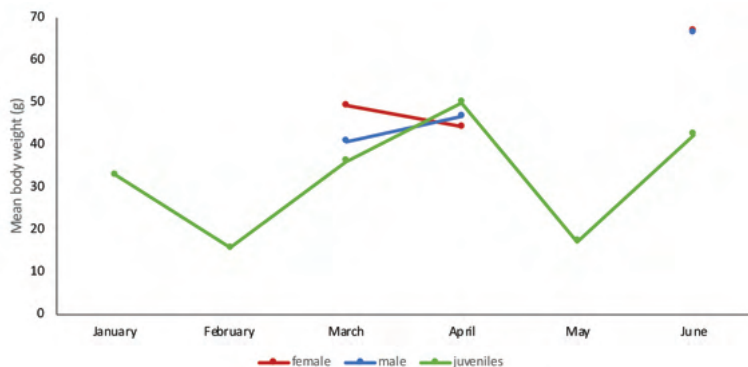
(B) Wild male kawakawa that mature in captivity for 10 months

- *Shortfin scad*

Collection of shortfin scad samples from the wild continued in 2022 to study and develop an efficient transport protocol and broodstock tank management. Using two otoshi-ami set-ups located at the municipalities of Barbaza and Tibiao in Antique, Philippines, 381 samples were collected from January to June 2022. Body weight ranged from 49.32 g to 66.7 g for female samples, 40.73 g to 66.50 g for male samples, and 15.80 g to 49.90 g for juveniles. Female and male samples collected in June and juveniles collected in April recorded the highest mean body weight among the collection.

To learn more about the reproductive biology of the shortfin scad, gonad samples were collected from the animals and submitted for histological analysis. An interesting observation was noted since the GSI levels of the animals, categorized by month of collection, follow the same increase-decrease pattern as its average mean body weight. In the figure below, broken lines represent the assumption of 0 GSI from samples collected in February since dissection was not possible because of the deteriorating quality of the fish. Furthermore, mature female samples have consistently higher GSI compared with males in the months of March, April, and June.

In terms of gut content, most of the samples had an empty stomach and, in some samples, only carcasses of small shrimps were found.



Mean body weight of shortfin scad collected from January to June 2022



GSI of shortfin scad samples collected from January to June 2022

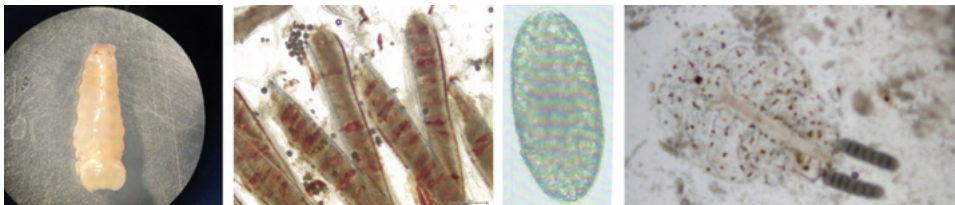
Moreover, ideal practices and protocols for handling and transport of shortfin scad from the wild to tanks were studied under this Project. Live shortfin scads were stocked into temporary fish cage for pre-transport conditioning for 0–3 days, wherein the fish were fed anchovy fries. Fish were either packed in oxygenated bags with 15 L of seawater and 0.05 g/L sodium nifurstyrenate or in customized transport tanks with chiller. High survival rates were achieved after three hours of transport.

Shortfin scad breeders were maintained in 10-ton tanks covered with B-net at AQD Tigbauan Main Station. Breeders were fed daily with fresh or thawed anchovy fries and *Acetes* or crushed milkfish broodstock diet to satiation level. Fish were kept in a seawater flow-through system with aeration. Regular draining and replenishment (70–80 %) of seawater were carried out to prevent algal bloom. For the first quarter, water parameters were monitored daily with ranges as follows: temperature 25.65–30.2 °C, salinity 31.5–35.8 ppt, DO 5.8–7.7 mg/L, and pH 7.9–8.3. As for the second quarter, shortfin scad breeders were maintained using the same feeding method using the following water parameters: 27.1–30.2 °C, 31.5–34.3 ppt, 5.7–6.8 mg/L, and pH of 7.9–8.5.

The shortfin scad was compared to another *Decapterus* species, redbtail scad. In terms of growth, it was observed that shortfin scad grew faster compared to redbtail scad through faster eye pigmentation and faster opening of the mouth of larvae. Shortfin scad obtained a mean total length of 0.7 cm and mean body weight of 0.1 g in 25 days of culture while the redbtail scad can be harvested at 30–35 days to reach the same aforementioned size. Both were fed rotifer, *Artemia nauplii*, and formulated diet during the larval rearing period. Feeding trials and water management will be carried out to further improve larval survival.

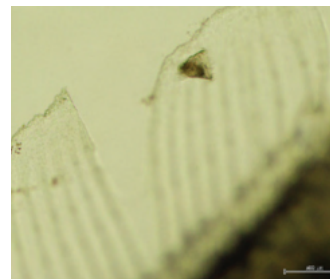
Spawning episodes which started in 2021, continued until 2022. It was observed that breeders were able to spawn on any days of the month without following a particular lunar rhythm. During the second quarter, shortfin scad only spawned once, during May. For the shortfin and redbtail scad species being observed under this Project, their eggs were pelagic and could be collected through PVC airlift egg collectors, similar to the materials used in other marine fish species with pelagic eggs. Eggs were collected at 7:00 a.m. and stocked in 250-L fiberglass tank for incubation. The highest monthly mean fertilization rate was observed in January 2022 while the monthly mean hatching rate was highest in February 2022. The highest monthly mean survival rate was obtained in January with survival rate ranging from 0.01–20.4 % at 25 days of culture. Decreasing egg production was observed which may be attributed to decreasing number of breeders due to handling stress during the proposed spawning documentation in the aquarium.

For breeders, after spawning stops for at least two weeks, caligid parasites were observed in some redbtail scad. Parasites were taken off manually using a fine cloth and fish were subjected to a freshwater bath for five min. Fish were then transferred to 250-L fiberglass tank; however, fish did not survive after three days. Furthermore, shortfin scad breeders were also infected with isopod and *Amyloodinium*. Fish infected with parasites were subjected to a freshwater bath for 30 sec and transferred to another tank.



From left to right: caligid parasite, isopod, and *Amyloodinium*

An episode of parasitic infection at the beginning of 2022 caused high mortality in shortfin scad during the course of larval rearing trials, including digenean, monogenean, *Amyloodinium*, protozoans, and an unknown parasite. Larvae were wiped out in three days upon infection of these parasites, possibly due to poor water quality. A water sample from the shortfin scad tank was submitted weekly for bacterial monitoring. Results showed a very high plate count, luminous bacteria, and presumptive *Vibrio* count. Moreover, presumptive identification of bacteria from moribund fish was noted with percent prevalence or sensitivity to the antibiotic.



An unknown parasite found in shortfin scad larvae

Due to susceptibility to parasitic and bacterial infection, stocks were monitored closely by immediately isolating moribund fish manifested by the dark coloration of the body surface, weak swimming behavior, or isolation from the schooling of fry, fingerling, or breeders. The use of UV-treated seawater was also recommended to prevent and avoid high mortality. Disease monitoring and analysis will continue in 2023.

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 alternative protein sources in fish and prawn 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.

Feeding trials using aquatic weeds, water hyacinth, and water cabbage to replace soybean meal in diets for tilapia in a biofloc-based system were continued in 2022. To enrich nutritional value, the aquatic weeds underwent a two-stage fermentation process and the proximate composition was analyzed to examine the effects of fermentation. Results showed that the fermentation increased the ash and moisture contents of water hyacinth leaf meals (WHLM) while the decrease in protein contents may be due to the slow growth of fermenting fungi and low secretion of some extracellular enzymes. Meanwhile in water cabbage leaf meal (WCLM), ash content generally increased after fermentation. An increase in crude protein and crude fat was observed in yeast-fermented WCLM.



Two-stage fermentation process of aquatic weeds

This study also aims to test the supplementation of insect meal and okara meal as replacers for fishmeal and soybean meal in diets for tilapia in biofloc-based and outdoor culture systems. In an experiment to replace fishmeal in tilapia diets, the efficacy of full-fat insect meal, specifically black soldier fly *Hermetia illucens*, was tested. Black soldier fly (BSF) larvae and adults, collected from a production facility, were analyzed for proximate composition. The larvae contained 36.35 % crude protein and 42.68 % crude lipid whereas the adult had 51.79 % crude protein and 23.68 % crude lipid.

The experiment was designed using five test diets (excluding control): insect larvae (BSFL) and adult (BSFA) meals replacing fishmeal and soybean meal at 6 % (BSFL6 and BSFA6), and 12 % (BSFL12 and BSFA12), which were formulated to contain 32 % crude protein and 9 % crude lipid. A fishmeal-based diet (FMO) was used as control. About 300 pieces of Nile tilapia fingerling, weighing approximately 5 g each, were randomly stocked in twelve 500-L capacity fiberglass tanks filled with 375 L of mature biofloc water. An initial stocking density of 25 pieces/tank was used and the tilapia were fed 5 % of biomass twice daily for a period of 16 weeks.

Results showed that, after 16 weeks, the mean survival rates were significantly higher at the control (93.3 %) than those fed with the BSFL12 diet (80.0 %). However, no significant differences were observed in the specific growth rate of 1.43–1.55 % per day and percent weight gain of 351–410 % among the dietary groups. Feed efficiency was significantly higher in the control and BSFL6 group than in the BSFL12 group.

The performance of the three test diets (control, BSFL6, and BSFL12) was also examined in tilapia reared in outdoor tank-based hapa net cages for 16 weeks. Mean survival and specific growth rates were comparable among dietary groups. Similarly, weight gain did not differ significantly in all three test diets. However, the feeding efficiency was found lower in the control group compared to that of the BSFL12 group.

The study also tested BSF larvae and okara meals as alternative feed ingredients in giant freshwater prawn (GFP) diets. Postlarvae, with an initial weight of 0.21 g, were stocked at 25 pieces/tank in 500-L capacity polyethylene tanks with an effective water volume of 250 L. These were initially fed with 10 % of estimated prawn biomass with three formulated test diets (38 % crude protein and 9 % crude lipid) with 0 % (fishmeal-based), 12.5 %, and 25 % of BSF larvae and okara meals. Another trial was set up in small hapa net cages to examine the performance of formulated diets in GFP outdoor culture. Preliminary results, after six weeks, showed that the percent weight gain and specific growth rate were higher in biofloc-reared GFP postlarvae than those reared in clearwater conditions. Similar results were observed for feed efficiency and survival rates; all were higher in biofloc-reared GFP postlarvae. The inclusion of BSF larvae meal up to 25 % (on a protein basis) positively enhanced the growth performance of GFP postlarvae in biofloc-based condition. However, this was not the case for the clear water condition, where weight gain, specific growth rate, and feed efficiency slightly decreased with increasing BSF larvae meal in the diet.

In the outdoor cage trial, the initial weight of 0.34 g increased between 3.42 g in the control group and 4.46 g in the BSFL12 group after eight weeks. Weight gain and specific growth rate were higher in the BSF-fed group compared with the control group. Similarly, feed efficiency was higher in prawns fed BSF-based diets than those given fishmeal-based diets. Survival rates were more than 90 % and were comparable among the dietary groups.

In 2023, the study will use the best-performing diet identified in previous GFP feeding trials and evaluate the performance of PLs in tanks and lake-based cage conditions when subjected to feed restriction.

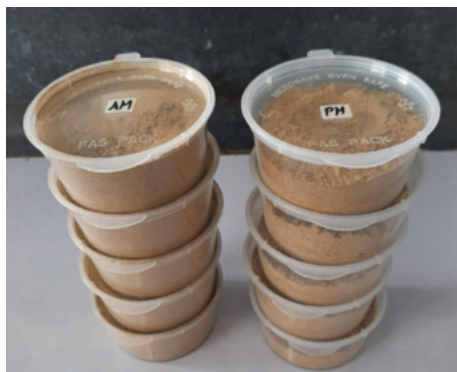
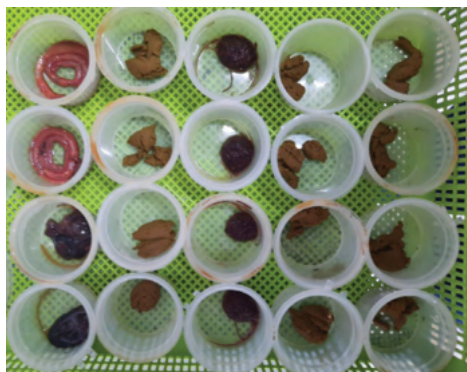
Promoting anguillid eel culture in Southeast Asia through improvements in feeds and feeding, and health management

This study aims to continue the feasibility of nursing Philippine native glass eels and elvers in captivity to address the problems of the high cost of feeds and potential pathogens during culture. To address this objective, two independent nursery-rearing trials were conducted in AQD Binangonan Freshwater Station (BFS) and Tigbauan Main Station (TMS).

In BFS, the effects of the feeding regime on the growth and survival of glass eels were tested in four replicates each: *Tubifex* spp. (TUB; Treatment A), egg custard-1 (EC1; Treatment B), egg custard-2 (EC2; Treatment C), TUB-EC1 (Treatment D), and TUB-EC2 (Treatment E). Glass eels of *A. bicolor pacifica* (0.12 g) were stocked in 80-L capacity plastic

drums (effective water volume of 40 L) at an initial stocking density of five individuals per liter. After 58 days, the glass eel growth rate was significantly higher in the *Tubifex*-fed group, whereas survival rates were comparable between TUB, TUB-EC1, and TUB-EC2, suggesting the need to improve the egg custard formulation to enhance performance in terms of growth. In an attempt to examine the effect of feeding stimulants for rearing glass eels (0.11 g), three groups were fed basal diet (BD) with and without feeding stimulants at 1 % inclusion level at four replicates each (I-BD; II-BD + yeast; III-BD + shrimp soluble extract (SSE); and IV-BD + taurine). After 47 days, no significant differences were observed in growth and survival rates among glass eels fed diets with feeding stimulants. The feeding trial will be extended up to 90 days to demonstrate clearly the effects of feeding stimulants on glass eel performance.

In another experiment conducted in TMS, the potential use of annelids as starter feeds for glass eels (0.41 g) and their influence on bacterial loading was investigated. The following treatments were examined in four replicates each: Treatment 1 (100 % *Marphysa*); Treatment 2 (50 % *Marphysa* + 50 % formulated eel diet); Treatment 3 (*Tubifex*); Treatment 4 (50 % *Tubifex* + 50 % eel diet); and Treatment 5 (100 % eel diet). Preliminary results showed that, after 45 days, groups receiving *Tubifex* were heavier and longer compared to the other groups. Survival rates were very high, ranging from 98.75 % to 100.00 %. The total plate or bacterial count was generally high at day 21 in most treatment groups. Glass eel samples that manifested a tumor-like structure or black and green coloration in the stomach were collected and processed for further analysis.



Live food and formulated eel diet used in nursery rearing trials

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

Farming of high-value giant freshwater prawns (GFP) holds a good potential to improve income for inland fishing communities. However, the 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.

Following the social preparation and formulation of local policies and governance strategies conducted in 2020 and 2021, the study now aims to further establish the GFP hatchery and nursery in the adopted community, Barangay Pipindan in Binangonan, Rizal, with newly-established Pipindan Aquaculture Producers Association (PAPA) as primary Project stakeholders.

In 2022, the study successfully signed the Memorandum of Agreement (MOA) to create a tri-party collaboration between PAPA, local government unit of Barangay Pipindan, and AQD, with support from the Government of Japan Trust Fund. Subsequently, a usufruct agreement with the owner of the land area that will host the hatchery has been signed.

To enhance the knowledge and skills of the PAPA members of GFP culture, daily capacity-building activities on the breeding and production of GFP postlarvae were conducted in a temporary hatchery setup in AQD Binangonan Freshwater Station from March 2022 onwards to the present. The PAPA members observed and assisted in the hatchery and nursery activities, including stocking breeders in hapa net cages on the shore of Laguna Lake and stocking gravid breeders in incubation tanks. They also collected larvae for stocking and rearing to postlarvae in drums with formulated brackishwater. Artificial brackishwater (12 ppt) has to be formulated because Barangay Pipindan in Laguna Lake has no access to brackishwater due to the closure of the Napindan Channel that supposedly connects the lake to Manila Bay through the Pasig River.

The initial selling of the postlarvae produced by PAPA members also happened in 2022. Eight buyers were supplied with GFP postlarvae from June to December 2022. A total of 12,828 postlarvae were reared by the PAPA members during the capacity-building activity, of which 29.5 % were sold during the six-month period since start-up. Price ranged from PHP 1 to 3 (approximately USD 0.2–0.5) per piece, depending on the size and age. The total gross sale was PHP 10,110 (approximately USD 185), with 40 % went to the PAPA members who were involved in the production and 60 % went to the cumulative fund of the association as agreed and stipulated in the organization's constitution and by-laws. However, the production of the PAPA members was very limited to serve all requesting clients, which led to pushing delivery to later dates. The production which was challenged by the mortality of larvae can be attributed to the limited skills of the PAPA members as beginners in the hatchery and nursery culture, delays in scheduling the availability of the formulated brackishwater and its inconsistent quality, poor compliance with prescribed feeding protocol using *Artemia* and egg custard, and occasional water temperature fluctuation during inclement weather and cold season. In addition, two typhoons, Noru (locally known as Karding) and Nalgae (locally known as Paeng), hit the pens and cages in Laguna Lake in September and October 2022, respectively.

Nevertheless, one of the highlights of the study was that the GFP hatchery, designed to hold 30 units of 80-liter-capacity larval rearing tanks, reached the final stage of construction, leaving the application of electricity and water supply to be conducted together with safety inspections.

In less than one year of hatchery operation, the survival rate widely ranged from 0.3 % to 26.7 % within a drum with about 4,000 larvae. While survival rates among drums only ranged at about 3–5 % out of 30 drums. Often, larvae collapse in the first two weeks of rearing in formulated seawater.



Some officers and members of the Pipindan Aquaculture Producers Association at the giant freshwater prawn, locally known as ulang, hatchery with Dr. Sayaka Ito, Deputy Chief of AQD and Government of Japan Trust Fund Co-Manager

To initiate the value chain for GFP, a market-linking field trip was conducted in September 2022 in Calauan, Laguna, particularly in Barangay San Isidro, with its constituents who are tilapia breeders. The aim of the field trip was to connect the PAPA members to the potential growers of GFP and to secure the market for postlarvae in the area. Five individual farmers who expressed interest in grow-out prawns were invited to attend the GFP lecture and practical sessions conducted in November 2022 under a regular training course conducted by AQD at its Binangonan Freshwater Station. Subsequently, the fisherfolks in Calauan agreed to receive prawn samples and excavated their ponds to increase the depth, making them more suitable for GFP culture. Growth and economic data will be collected from these farms for evaluation. These subsequent needs for postlarvae for grow-out will then be ordered from PAPA at determined prices.

For 2023, the study will continue to achieve its goal of sustaining the production and selling of postlarvae to generate revenue for fisherfolk organizations for the maintenance of their hatchery operation and provide supplemental income to participating members. The study also aims to enhance the training in broodstock management, sustain the community-based hatchery operations and family-based grow-out, and explore trial ranching opportunities in Laguna Lake and tributaries.

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, SEAFDEC/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 2022 were as follows:

Broodstock management, breeding protocol development for seed production, stock management/enhancement

- *Giant freshwater prawn*

A study was done to verify the efficiency and cost of producing all-male giant freshwater prawns through the removal of their androgenic glands in order to increase harvest yields as male prawns grow larger than females. After microsurgery, females that showed signs of ovarian development were paired with normal males and then separated after successful mating. However, most potential neo-females died during the pairing, while others died even before gonadal development. So far, only three were able to lay eggs. Unfortunately, these eggs were either aborted or the female died days after fertilization.

Refinement of hatchery and nursery protocols

A. Improvement of rearing protocols

- *Pompano*

A study was done to determine the optimal conditions for rearing of snubnose pompano (*Trachinotus blochii*) in pond-based net cages. The study evaluated the best nursery diet and optimal grow-out stocking density. Results showed that pompano growth in the nursery was better with higher body weight and food conversion ratio (FCR) in two SEAFDEC-formulated diets compared to a commercial diet. In the grow-out experiment, the best stocking density for pompano culture was at 1.0 individual/m² (compared to densities between 0.3 individual/m² and 0.7 individual/m²) with higher body weight and total biomass after 180 days. All treatments had similar specific growth rates (SGR) and FCR.



Harvested pompano

- *Mangrove crab*

A study was done to evaluate the effectiveness of biofloc technology on larval rearing of mangrove crab in terms of growth, survival, stress, and disease resistance. In 2022, one run showed a higher survival rate in clear water (from zoea 1 to zoea 5), and green water (from megalopae to crab instar), while the average weight was highest in biofloc water from zoea 1 to crab instar 1. For the stress tolerance tests, biofloc water showed the best results. In

indoor nursery rearing experiments, two runs were conducted with inconsistent results; thus, another run will be conducted in 2023 to verify the results. An LD₅₀ experiment was also conducted to determine the concentration of viral inoculum to be used in a disease challenge experiment in 2023.

Another study was done to determine the ideal stocking density and culture period of mangrove crab megalopae in pond-based net cages in order to develop a feeding management protocol and evaluate the economic viability of the nursery culture operations. The study involved four stocking densities (50, 100, 200, and 300 individuals/m²) with six replicates each and a 3 to 4-week culture period. Megalopae (initial weight of 0.003 g) were fed a combination of formulated diet and macerated mussel meat. Four experimental runs yielded mixed results.

Regardless of stocking densities from all trial runs, crab instar body weight ranged from 0.16 g to 0.46 g after three weeks and from 0.40 g to 1.12 g after four weeks. On the fourth week of culture, a stocking density of 50 individuals/m² yielded the highest body weight in the third trial run. The study produced 7,420 pcs of crablets and 5 kg of marketable-size crabs.

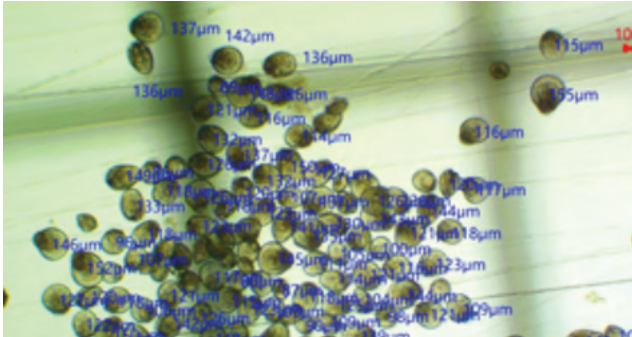


Harvest of matchbox size crablets

- *Oyster*

A study was done to investigate the best algal rations for oyster (*Magallana bilineata*) growth and survival during their larval and spat stages. Three feeding rations (low, medium, and high) at different larval stages were used and rations based on the age, larval stage, and estimated number of larvae in each tank were computed. The results showed that the medium algal ration consistently produced larger larvae compared to the low and high rations, but had a rapid decline in survival rate at the onset of day 12.

It was hypothesized that the decline in survival rate was due to the lack of cultch for the larvae to settle in. Different spawning techniques, such as thermal induction, overnight desiccation, flowing seawater, and gonad stripping were also tested. Thermal induction produced normal quality and high survivability of larvae. The protocol for broodstock development and conditioning will be optimized in 2023.



Measurement of oyster larval shell length under the microscope

- *Seaweeds*

A study was done to produce tank-acclimated seaweed micropropagules. The study also expected to determine if tank acclimation favors better growth and survival over non-acclimation when seaweed micropropagules are later planted in the open sea. It also sought to determine the effective stocking density and optimal acclimation time for seaweed propagules in laboratory-based tanks during the acclimation phase. Results showed that tank acclimation was effective in increasing the survival and growth rates of propagules in the sea cage nursery system. Shortening the culture period of the seaweeds in the laboratory to 30 and 60 days likewise favored good growth rate.

Another study aimed at improving the production of seaweed propagules/plantlets, reduce the cost of production, and provide quality propagules. New cage facilities were built to achieve the objectives, resulting in a production of 22,593 tissue-cultured plantlets in 2022. The survival rates of propagules have been inconsistent with 40.5 %, 28.9 %, and 31.6 % in the years 2020, 2021, and 2022, respectively. Biosecurity measures are being taken to prevent disease in seaweeds, with treatment trials using commercially available disinfectants being conducted.



Tissue-cultured Kappaphycus alvarezii plantlets

- *Sandfish*

A study aimed at increasing the survival rate of early juvenile sandfish, producing at least 90,000 pieces of early juvenile sandfish per spawning batch, achieving 12 spawning batches per year, and producing 1 million early juveniles per year. The study achieved 14 spawning runs during which the target of more than 2 % survival rate was achieved in May and June 2022. However, issues with the algal food supply, copepod infestations, and inclement weather led to lower survival rates in other months.

B. Production of non-conventional feed ingredients for use in broodstock diets

- *Mudworm*

A study was conducted to mass-produce the polychaete *Marphysa iloiloensis* to support in-house research projects and crustacean hatcheries at AQD. The study also aimed to develop a protocol for the mass production of specific pathogen-free *M. iloiloensis*. In 2022, the polychaetes spawn weekly in broodstock tanks. From January to November, 1,114 cocoons were collected, of which 67 % contained viable eggs. The rest of the eggs were bad or were positive for monodon baculovirus (11 %). A comparison between the growth and survival rates of hatchery-bred and wild polychaetes showed higher survival rate (78.62 %) in the wild compared to hatchery-bred (43.4 %). The growth rate and body length of hatchery-bred and wild polychaetes were not significantly different. It should, however, be noted that in hatchery-bred polychaetes, eggs used came from the offspring of old breeders (~ 3 years of age), in which inbreeding may have happened among the stocks. Thus, the collection of polychaete eggs from the wild and growing them to adult should be undertaken every three years to improve the genetic variability among breeders in the hatchery. To boost production, 10 modular setups with 30 circular tanks each were constructed in 2022 for grow-out. A screening protocol will be implemented to produce specific pathogen-free polychaetes by screening the larvae for commonly known viruses before they are stocked in tanks.



Modular tank setup for the grow-out culture of polychaetes

C. Production of alternative natural food organisms for hatchery and nursery rearing of commercially important aquatic species

- *Larval food*

A study was carried out to increase the biomass yield of *Nanochlorum* sp. and rotifer *Brachionus rotundiformis* using a modified continuous culture system. The optimal pH for *Nanochlorum* culture was determined to be 7.5–8.5 and the culture system used a cost-effective TMRL medium at a lower nitrate concentration of 50 mg/l. The system's dilution rate was controlled with a gate valve-brass cock connection and *Nanochlorum* thrived at 25–33 ppt salinity. A 30 % dilution rate was established for the modified continuous culture system, and it was found that the starter/inoculum could be changed every 3–4

days to extend growth. With the use of *Nanochlorum*-tilapia water treated with 2.22 ppm bleach, increased cell yield and higher rotifer growth were achieved. It was also found that the culture of *Nanochlorum* was not significantly affected by salinity fluctuation. The culture period for the entire system can be extended using *Nanochlorum*-tilapia water. The modified continuous culture system (plus the tilapia) was done in large-scale set-ups where outflow water was used to produce *B. rotundiformis*. This is to try to show the system's potential for efficient commercial use by reducing the number of tanks and labor input.

- *Rotifer*

A study was done to determine the best feeding rate of centrifuged *Chlorella sorokiniana* paste for the production of the rotifer, *Proales similis*, and determine the feeding rate of *P. similis* as the first food in the larval rearing of small-mouthed marine fish. It was determined that the best starting density to grow *P. similis* was 200 individuals/ml. *C. sorokiniana* feeding rate was best between 2.5×10^6 cells/ml and 10×10^6 cells/ml, although the lower range was recommended for economic considerations. The best culture condition was the batch culture system with a black net or sack covering and using 2-point aeration. Results showed that the peak *P. similis* production was at 343 individuals/ml after 3–4 days of culture. Larval rearing trials with rabbitfish (*Siganus guttatus*) showed promise but will be confirmed with more runs in 2023.

- *Copepod*

A study was conducted to mass produce harpacticoid copepods (*Tigriopus* sp.) in large tanks for use as the first food in marine fish larval rearing. The results showed that while the combination of harpacticoid copepod and cyclopoid was better for rabbitfish larval rearing, the best survival rate was achieved when rotifers were fed. For grouper larval rearing, the best survival rate was achieved with 4-day-old larvae fed a combination of copepod and cyclopoid, followed by those fed solely with harpacticoid copepod. Trial runs would be conducted to further verify the results of larval rearing experiments.



Cyclopoid copepod under the light microscope

D. *Promotion of technically and economically viable breeding and seed production schemes*

- *Tilapia*

A study was done to produce improved strains of Nile tilapia and red tilapia fingerlings for culture by fish farmers as well as to produce mixed-sex and all-male tilapia fingerlings for use in both brackishwater and saltwater culture areas. The target was to produce 50,000–70,000 pcs of tilapia fingerlings per month. In 2022, a total of 414,700 tilapia fry were produced and 396,850 fry were sold to tilapia farmers in the Philippines. Lower production was attributed to the use of an old and limited number of available broodstock in the hatchery.

- *Abalone*

A study was done to produce 25,000 abalone juveniles, evaluate the impact of different broodstock diets on their reproductive performance and growth, and assess the effectiveness of artificial diets for early weaning. From January to August 2022, 56,367 abalone juveniles were produced. The experiments on comparing mature abalones fed fresh seaweeds and maturation diet is ongoing. The feeding experiment showed that abalone juveniles fed seaweeds had better shell growth rate compared to those fed with other diets, including refined and unrefined pellets and flakes. The least growth rate was observed in those fed with a mix of diatoms and *Spirulina* powder.

- *Mangrove crab*

In 2022, the reproductive performance of mangrove crab broodstock was monitored. The crabs were collected from various sources including the provinces of Aklan, Iloilo, Capiz, Masbate, Samar, Sorsogon, Surigao, and Zamboanga. Out of 235 broodstock, 198 died and only 89 crabs spawned. Zoa produced by each spawner ranged from 0.1 million to 5.3 million. Individual quarantine of broodstock was done resulting in lower mortalities and higher likelihood of spawning. Mortalities in the larval rearing were observed which may be due to the change in prophylaxis. Alternative prophylaxes are being tested to verify the efficacy, dose, and frequency that will increase larval survival rate. The hatchery produced 332,938 crab instars and 8,040 megalopae which were distributed to local fish farmers in the Philippines.

- *Giant freshwater prawn*

A study was done to refine the hatchery protocols for giant freshwater prawn (*Macrobrachium rosenbergii*) to produce a stable supply of postlarvae for research and distribution to fish farmers as well as perform the cost-benefit analysis of prawn hatchery operations. From January to October 2022, 72 prawn broodstock (average weight of 39.53 g/individual) produced 1,511,075 larvae that yielded 174,063 postlarvae. No production was undertaken in April, however, due to a transfer to a new facility; while the production from October to December was hampered by larval mortalities due to unfavorable weather conditions.

- *Seaweed*

A study was performed to enhance the production of seaweed propagules by improving their survival, produce micropropagules for the sea-based nursery, and perform cost-benefit analysis of the operations once data on the land-based nursery production of seaweed micropropagules is available. From January to December 2022, 22 batches of propagules, composed of 69,611 pieces *Kapapaphycus alvarezii* propagules, were transferred from the land-based nursery to the sea-based nursery at the AQD Igang Marine Station. The average survival rate of *K. alvarezii* in the laboratory was 87.9 %.

2.3 Ensuring food safety through sustainable aquaculture methods

In 2022, 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. To secure the profits of fish farmers and the safety of aquaculture products, AQD conducted studies under this Program as follows:

Vaccination of cage-cultured marine fish

In 2018, a study established a pragmatic protocol for producing nervous necrosis virus (NNV) specific-free eggs from immunocompetent sea bass broodfish reared in land-based tanks through an annual vaccination regimen with the formalin-inactivated NNV. As an offshoot, a practical application study of this vaccination regimen, which started in 2020, was continued in 2022.

In 2022, experiments on determining the NNV-neutralizing antibody titer in vaccinated and unvaccinated pompano broodfish continued. Marine fish were primarily vaccinated in 2020 and received the first booster vaccination in 2021. In those experiments, it was observed that NNV-neutralizing antibody titers could already be detected in the sera of vaccinated fish at one- and two-month post-vaccination, peaked at month 3, but thereafter gradually declined and significantly dropped at month 12 post-vaccination. A second booster vaccination was administered 12 months after the first booster vaccination. Collection of blood samples for the determination of NNV-neutralizing antibody titers in the sera of both vaccinated and unvaccinated (control) fish had already been conducted one and two months after the administration of the second booster vaccination. Subsequent samplings were conducted every month from the 4th to the 12th month post-second booster vaccination. NNV-neutralizing antibody titers in the sera of vaccinated fish collected at two and three months after the second vaccination were $1,024 \pm 350$ and $2,432 \pm 286$, respectively, while in unvaccinated fish, the titers were below 1:40. Data collection on the determination of neutralizing antibody titer in both vaccinated and unvaccinated fish after the second booster vaccination will continue in 2023.

In addition, the study also aims to examine the presence of NNV in the milts and eggs of booster-vaccinated and unvaccinated broodfish prior to inducing spawning. Results of the experiments in 2022 showed that milts and eggs and as well as spawned eggs from vaccinated and unvaccinated pompano broodstocks were negative for NNV detection by RT-PCR (2020, 2021, and 2022 induced spawning). No incidence of abnormality and mortality has by far been observed among offspring of vaccinated and unvaccinated fish reared at the hatcheries of AQD Tigbauan Main Station.

For this study, almost a hundred high-value marine fish species (including pompano, grouper, sea bass, and snapper) reared in floating net cages in AQD Igang Marine Station in Guimaras, Philippines had already been given first and second booster vaccinations.

Control of pompano sea lice infestation

Sea lice (*Caligus*) infestation is one of the most significant diseases affecting the culture of pompano. Parasitic copepods are widespread and can seriously threaten marine and brackishwater fish culture. Thus, there is a need to look for effective treatments to reduce the sea lice infestation of on pompano. A field trial demonstrating the efficacy of emamectin benzoate (EMB), hydrogen peroxide, and freshwater bath for the control of sea lice on pompano was conducted from 2021 until 2022.

Results of the experiments revealed that in freshwater bath treatment, the prevalence of sea lice reduced from 100 % in pre-treatment to 80 % during the third-day post-treatment. It gradually increased towards the 21st day reaching 100 % at the end of the experiment. The mean intensity of sea lice significantly decreased ($p < 0.05$) on the third day and gradually increased towards the 21st day. In the control, the mean intensity increased and fluctuated towards the end of the experiment. Additionally, adult male and female sea lice were present in all sampling dates in the control group; whereas, in the treated group, adult sea lice were not found on the third day but reappeared on the seventh day.

Similarly, hydrogen peroxide bath treatment showed comparable results with freshwater bath. The experimental result showed that the prevalence of 1,500 ppm (65 %) and 2,000 ppm (45 %) on the third day were significantly lower ($p < 0.05$) compared to full seawater (100 %). After seven days, the prevalence was at 100 % for all treatments. The mean intensity of sea lice significantly decreased ($p < 0.05$) on the third day and started to increase on the seventh day. In contrast, the mean intensity from the control group gradually decreased over time starting from the pre-treatment. Moreover, the presence of adult sea lice was retained throughout the experiment while in treated groups male and female sea lice were absent on the third day of monitoring but recurred on the seventh to the 21st day.

EMB was used as an in-feed treatment for pompano infected with sea lice. Pompano was fed with a diet containing 1.67 mg/kg EMB, whereas the control was fed with only high-value diet feed for seven days. After that, sea lice were monitored every week for a span of 56 days. There was a slight reduction post-feeding on the 14th–35th day (85–95 %) in the prevalence of sea lice in the treated group while the control group retained 100 % prevalence until the 56th day of monitoring. However, prevalence increased to 100 % from 42 % on the 56th day. The lowest prevalence was observed on the 35th day with 85 % prevalence. In the mean intensity of sea lice, there was a significant reduction starting from the 14th day to the 56th day in the treated group whereas no significant reduction in

the control all throughout the experiment. Although the mean intensity was significantly reduced in the treated group, adult female and male sea lice were still present up to the 56th day.

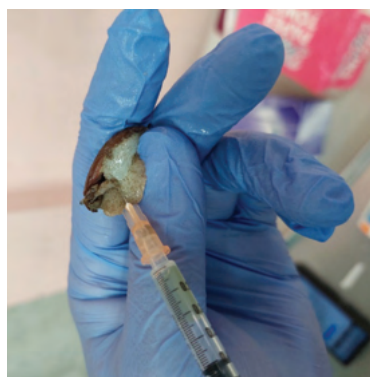
Probiotic supplementation for juvenile abalone

Poor diet digestibility, a concern in aquaculture nutrition, is often caused by a low activity of digestive enzymes in the animal's intestinal tract. This study was conducted to validate the potential of *Bacillus amyloliquefaciens* as a probiotic on abalone, *Haliotis asinina* to shorten the culture period of late juveniles, improve feeding efficiency, and reduce aquaculture costs. *B. amyloliquefaciens* has the ability to produce various types of enzymes, including amylase, protease, lipase, cellulase, and others.

Different concentrations of *B. amyloliquefaciens* in the diet were tested for their effect on the growth, survival, and immune response of juvenile abalone. Using early juvenile abalones stocked in plastic tanks with 120 L of filtered and strongly aerated seawater, with a stocking density of 120 individuals per fine-meshed plastic tray. The treated groups were fed with *Gracilaria* sp. preconditioned for 48 h in 10^5 cfu/ml (Treatment 1) and 10^7 cfu/ml (Treatment 2) *B. amyloliquefaciens*. The control group was fed with *Gracilaria* sp. soaked in UV-filtered seawater. The experiment lasted for 180 days until the abalone reached the ideal grow-out size of 25–30 mm. Results showed that the total weight gain, total shell length gain, the specific growth rate in terms of weight and length, and the survival rate of the treated groups were comparable with that of the control group. The feed conversion ratio (FCR); however, showed that the treated groups had higher FCR than the control group.

To evaluate the effect on immune response, three abalones ranging in shell length from 25 mm to 31.5 mm were randomly collected from each group. The hemolymph was extracted from the pedal sinus and the number of hemocytes was counted using a hemocytometer at 400× under a microscope. The total number of hemocytes was not significantly different between Treatment 1 and Treatment 2 but Treatment 2 had a significantly higher total hemocyte count than the control group. In theory, a higher hemocyte count translates to a better immune response as demonstrated by a higher survival rate in the Treatment 2 group.

At the end of the experiment, it was concluded that probiotic supplementation through preconditioning of *Gracilaria* sp. was an ineffective delivery method for abalones. The formation of a thick biofilm on the surface of the seaweed could have compromised its palatability to abalones and has affected other feeding factors. In the succeeding trials, probiotic delivery will be modified by mixing probiotics with abalone-formulated feeds.



Extracting hemolymph from the abalone

Epidemiology of the skin ulcerative disease in sea cucumber

This new study aims to investigate the epidemiology of skin ulceration disease (SKUD) that has erratically affected the hatchery-reared and sea pen-cultured sea cucumber. In addition, the study will document the occurrence of SKUD in some of the sea cucumber broodstock samples collected from the wild.

As documented in some published studies, the occurrence of SKUD in sea cucumbers usually happens due to a sudden drop in temperature and high stocking densities. The infection could also rapidly spread from infected stocks to healthy ones, making it difficult to control.

Accordingly, a 2022 census noted the disease occurrences at the hatchery and the grow-out phases of the sea cucumber culture. In the hatchery phase, bacterial loads in sea cucumber's larval rearing water were examined in two production cycles. Water samples were collected weekly from five larval rearing tanks during the first production cycle for 40 days and in three tanks during the second cycle for 42 days. The experiments attempted to quantify the heterotrophic plate count (HPC), presumptive *Aeromonas* count (PAC), and presumptive *Vibrio* count (PVC). Results showed no significant differences with regard to the levels of HPC, PAC, and PVC in the water samples examined. Similarly, the water physicochemical parameters (dissolved oxygen, salinity, temperature, and pH) did not significantly vary among the tanks observed in both production cycles.

Bacterial loads were also examined in the rearing water, sediment, and coelomic fluid of sea cucumber broodstocks reared in land-based tanks. Two batches were conducted for this experiment using three broodstock tanks for each batch. For batches one and two, samples were collected weekly for a period of two months and 20 days and every two weeks over one month, respectively. Similarly, HPC, PAC, and PVC in these aforementioned samples were determined. Results showed no significant variations regarding HPC, PAC, and PVC in the water, sediments, and coelomic fluid samples collected from each tank during sample collections. However, four sea cucumbers with moderate to severe SKUD were documented in the first batch of samples collected. Notably, while bacterial loads in the coelomic fluid of apparently healthy sea cucumbers were all undetectable or below the detection limit, the HPC, PAC, and PVC in the coelomic fluid of sea cucumbers with moderate to severe SKUD were remarkably high, as supported by counts of up to 10^7 cfu/ml, 10^6 cfu/ml, and 10^4 cfu/ml, respectively. No occurrence of SKUD was encountered in the second batch of sea cucumber samples examined.

Employing the same sampling protocol in land-based tanks, sea cucumbers reared in sea-based net pens in AQD Igang Marine Station in Guimaras, Iloilo were also collected for bacteriological enumeration. Water ($n = 6$) and sediment ($n = 3$) samples were collected from three sampling points inside the pen every two weeks for three months. To date, of the 61 sea cucumber samples examined, 44 were categorized as healthy, while 9 and 8 individuals were found to be suffering from mild to moderate and severe SKUD, respectively.

Seaweed disease and pest detection

This new study aims to test commercially-available chemicals to treat seaweed plantlets infected with ice-ice disease (IID) and epiphytic filamentous algae (EFA) and prophylactic agents on seaweeds before and after translocation.

This year, the collection of IID- and EFA-infected tissue-cultured plantlets from the wild commenced. Subsequently, the preservation and maintenance of artificially infected stocks were also done. Seaweed plantlets at the Igang Marine Station sea-cage facility with observed EFA were collected and transferred to Tigbauan Main Station. IID-infected tissue culture plantlet samples were preserved in a biofreezer (-80 °C) for artificial infection.

Results of the immersion experiment using granulated chlorine (HI-CHLON 70; active ingredient calcium hypochlorite 70 %) at 400 ppm for 5 min (1-day treatment) resulted in the death of EFA by bleaching or whitening and complete detachment for the epiphyte filaments from the host seaweed.

Before treatment



After treatment



Preliminary result of EFA-infected seaweed plantlets treated with granulated chlorine at 400 ppm for 5 min

The result of the immersion experiment using sodium hypochlorite (10 % active ingredient) showed that concentrations of 200 ppm to 400 ppm for 5 min (3-day treatment) resulted in the death of EFA by bleaching/whitening and complete detachment of the epiphyte filaments from the host seaweed. Meanwhile, no results were obtained for hydrogen peroxide and citric acid chemicals, following the protocols above, even at 400 ppm concentration for 60 min (1-day treatment).

An experiment treating IID-infected seaweed plantlets with povidone-iodine was conducted. Seaweed plantlets with IID from the Igang Marine Station cage facility were transported to one of the laboratories in Tigbauan Main Station and acclimatized in tank condition. In the experiment, seven treatments were used in triplicate (using five pieces of seaweed plantlets each) and immersed in different concentrations (50 ppm, 100 ppm, 200 ppm, 300 ppm, and 400 ppm) of povidone-iodine for an hour. The treatments were repeated for three consecutive days and observed for five to seven days after treatment. However, the preliminary results of the study conducted in the farm set-up using IID-infected plantlets with low severity (< 10 %) showed healing of infected tissues. The infection severity level in the seaweed thallus could have placed in the effectiveness of the treatment.

Pompano culture in floating net cages

Pompano is considered one of the most desirable and high-value food fishes; however, technical details on cage culture protocols in the Philippines could be more extensive. This study aims to elucidate these details, including efficient stocking density, established growth rate and growth curve, optimum feed conversion efficiency, and optimum feeding rate.

In 2022, feeding experiments compared high and low feeding rates for 133 days of culture. The fish were fed in a 5 m × 5 m × 3 m cage at 2,500 individuals/cage (33 fish per m³). Results indicated that fish fed with the high feed rate achieved the highest body weight gain. However, fish in the low feed rate group exhibited better feed efficiency.

The optimum stocking density was observed through a 5 m × 5 m × 3 m cage for 126 days of culture of pompano. Results showed that increasing the stocking density in cages of up to 55 fish/m³ did not affect the final body weight of pompano during harvest. Furthermore, feed conversion was more efficient in the higher stocking density group.

The growth curve of the pompano was also determined by incorporating the optimum feeding rate and stocking density in the experiments mentioned above. Fish with a body weight of 60–70 g were used in the experiment. In the interval, pompano fingerlings weighing 3 g were used to determine the optimum stocking density (800, 1,000, 1,200, 1,400, and 1,600 fish/m³) of a nursery cage operation. A preliminary sampling was conducted in the late third quarter of 2022. Initial results showed that the treatments with lower stocking density yielded pompanos with higher average body weight after 60 days of culture. The observation for this experiment will continue until 2023.



Pompano harvested from the floating cages of AQD Igang Marine Station

Cost-effective ingredient blend for pompano diets

Studies on the use of alternative protein sources derived from plant and animal by-products for fish have been numerous and have given significant results. However, these ingredients have their limitations such as poor digestibility, which translates into a very limited maximum inclusion level. The incorporation of exogenous enzymes in fish feeds with plant proteins can significantly improve feed digestibility and eventually growth. The continuing study aims to come up with a cost-effective formulation for pompano grow-out in sea cages by replacing fish meal protein in formulations.

The formulation developed includes ingredients sourced from plants (soybean, corn protein concentrate, and PECM) and animal by-products (poultry by-product and hemoglobin meal). For the feeding trials, pompano juveniles with an average body weight of 7.1 g were stocked in 2 m × 2 m × 1 m floating net cages at 1,000 fish per cage. Initial data suggested that the blend of alternative protein ingredients had a lower performance parameter compared to the control diet. Reformulation efforts are ongoing.

A feeding experiment was conducted to find the adequate inclusion level of corn protein concentrate as an alternative ingredient adequate in the pompano diet. With this, a growth experiment in tanks (250 L capacity, 200 L water volume) was conducted with five treatments replacing fish meal with corn protein concentrate at 0, 20, 40, 80, and 100 % inclusion levels. This experiment suggested that corn protein concentrate can only replace fish meal up to 20 % inclusion level. However, increasing the replacement level further significantly affected performance parameters.

Another experiment was conducted in 2022 to determine the effect of enzyme inclusion level in dietary treatments containing more than 20 % corn protein concentrate. The diets were top-coated with Ronozyme Hi-Phos L as a source of phytase and Ronozyme Multi-grain L as a source of xylanase and glucanase enzymes. However, results showed that the addition of enzymes in dietary treatments did not improve the body weight gain of the fish. The digestibility of the diets and ingredients of all the dietary treatments is ongoing.

Fungi-fermented feed ingredients as alternative protein sources

Using fermented non-conventional feedstuffs such as plant meals can be an effective method for producing fish diets with high nutritional value at a lower cost, while also decreasing reliance on imported protein sources such as fishmeal and soybean meal.

In this study, two locally available forage plants, namely: “ipil-ipil” (*Leucaena* sp.) and “madre de cacao” (*Gliricidia* sp.), as well as an aquatic plant, *Azolla* sp., were fermented with the fungus *Aspergillus oryzae* and evaluated for their effect on the survival and growth of tilapia.

The fermented plant meals were added to iso-nitrogenous (30 % protein) and iso-lipidic (8 %) fish diets in increasing amounts. The inclusion levels of fermented ipil ipil leaf meal (FIILM) were 0, 8.75, 17.5, 26.25, and 35 %, which could replace up to 71.4 % of the soybean meal in the diet. On the other hand, fermented madre de cacao meal (FMCLM) and fermented *Azolla* sp. meal (FAzM) were added at concentrations of 0, 8, 16, 24, and 32 % to replace up to 53.4 % of soybean meal.

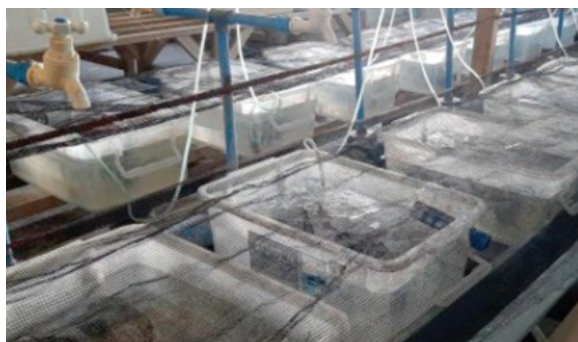
The experimental diets were fed to masculinized tilapia fry (0.2–0.3 g body weight) for eight weeks. Fish rearing was done in 250-L tanks following a stocking density of 30 fish per tank. A total of three feeding trials, one for each fermented plant meal, were conducted.

Results revealed no significant difference in fish survival rate across all treatments which ranged from 73 % to 97 % in the first trial, 73 % to 100 % in the second, and 67 % to 87 % in the third although the control group (no fermented meal inclusion) had a lower mean survival rate than the treatment groups.

The highest growth rates in Trial 1 were observed in fish fed with diets containing 17.5 % FIILM (weight gain = 5.2 ± 0.35 g, percent weight gain = $1,976 \pm 186$ %, absolute growth rate = 0.08 ± 0.005 g per day, specific growth rate = 4.6 ± 0.14 % BW per day). In addition, the growth rate of fish fed with diets containing up to 35 % FIILM was comparable to that of fish fed with the control diets. The quadratic relationship between inclusion level and growth demonstrated that tilapia can tolerate FIILM levels as high as 35 %, but levels closer to 17.5 % resulted in the greatest growth. Trials 2 and 3, on the other hand, demonstrated that up to 32 % of FMDCM and FAzM can be included in tilapia diets without impairing fish growth. Overall, the three feeding trials showed that fungi-fermented leaf meals can be included in tilapia diets at levels not lower than 30 %.

Culture of silver therapon in tanks and cages

Silver therapon (*Leiopotherapon plumbeus*) is one of the most valuable edible native freshwater species in the Philippines. Farming of this species could be a sustainable option for the growth of aquaculture in lake-shore fish farming communities. However, farming juveniles for grow-out requires a nutritionally-balanced diet for optimal growth and survival. To address this concern, a series of experiments were carried out to establish the basic nutrient requirements and develop diets and production techniques for silver therapon juveniles.



Set-up for the indoor rearing of 30-day post hatch silver therapon larvae

A modified formulation of the best-performing diet from a previous experiment was used to prepare six experimental diets containing different levels of dietary lipid (3.5, 6, 9, 12, 15, and 18 %), with Danish fish oil as the lipid source. Hatchery-bred silver therapon juveniles (3.60 g) were randomly assigned into six dietary groups in four replicates and fed diets at 5 % of fish biomass twice daily. After 12 weeks, final body weight (FBW), percentage weight gain (%WG), and specific growth rate (SGR) increased with increasing dietary lipid levels, with the best growth response noted at 12 % lipids. Better feed utilization was also observed in groups fed with diets containing 12 % lipids with a lower feed conversion ratio (FCR) of 2.30 compared to other groups. High survival rates were recorded in all dietary groups, ranging from 98.75 % to 100 %. Estimation of the optimal lipid requirement of silver therapon, based on percent weight gain, will be performed using a two-slope broken line or quadratic regression analysis, whichever is more appropriate.

Tank- and lake-based cage feeding trials were conducted to determine the optimum stocking density for the grow-out culture of silver therapon. Prior to the stocking density experiment, silver therapon fry, produced using the protocols previously developed by AQD, was further reared until 60 days post-hatch in indoor plastic tanks. After that, they were transferred in 1 m × 1 m × 1.5 m hapa net cages and reared until they reached 2–3 g body weight. The stocking densities, tested at four replicates each, were 15, 30, 45, 60, and 75 fish/m². Juvenile fish (2.73 ± 0.04 g in tank-based cages; 2.23 ± 0.07 g in lake-based cages) were fed a formulated diet (35 % crude protein, 12 % crude fat) four times daily for 16 weeks. Every two weeks, the growth rate was monitored and the feed ratio was adjusted based on the fish's bulk weight data.

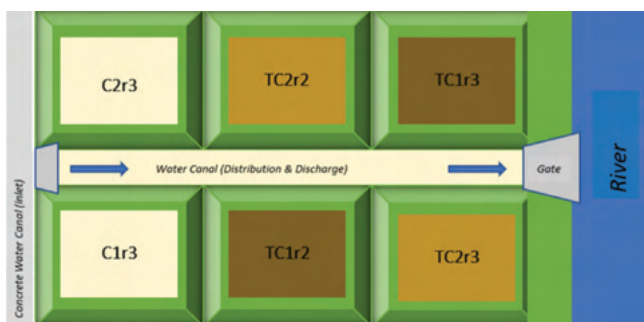
In the tank-based trial, after 14 weeks, mean body weight (BW) was comparable among all stocking densities ranging between 7.04 g (60/m²) and 8.00 g (30/m²). Mean percent weight gain (WG) and specific growth rate (SGR) were higher at 15/m² and 30/m² but did not significantly differ from those reared at the other stocking densities. Similarly, feed efficiency (FE; 27.88–30.94 %) and survival rates (98.33–100 %) did not significantly differ among the stocking densities.

In the lake-based cage trial, significant differences among the growth parameters were noted after 12 weeks. Fish reared at 30/m² and 45/m² stocking densities had significantly higher mean BW than those held at 60/m² and 75/m². WG, SGR, and FE in fish reared at 30/m² and 45/m² stocking densities were significantly higher than those reared at 75/m². Survival rates were significantly different among density groups, with > 95 % survival rate at 30, 45, 60, and 75/m² treatment groups. The stocking density trial will be continued in 2023.

Polyculture of tilapia and giant freshwater prawn using biofloc system

Based on existing literature, the protein and adequate balance of essential nutrients contained in biofloc environments complement the nutrient requirements of species like tilapia and giant freshwater prawn (GFP) either in monoculture or polyculture. This ongoing study aims to verify the efficiency and profitability of Nile tilapia-and-giant freshwater prawn polyculture under a biofloc system. In addition, the study will be also exploring the potential of satiation-based feeding rates for tilapia while GFP stocks are kept unfed.

Tilapia (*Oreochromis niloticus*) fry required by the experiment was masculinized following an existing protocol developed by the DA-Bureau of Fisheries and Aquatic Resources (DA-BFAR). Meanwhile, the GFP (*Macrobachium rosenbergii*) postlarvae were collected from AQD hatchery. Tilapia fry with individual weights ranging from 1.45 g to 2.94 g and GFP with individual weights ranging from 0.03 g to 0.15 g were stocked at 6 pieces/m² per species in a polyculture system.



Experimental layout of the polyculture system

Monitoring of the physicochemical water quality parameters such as dissolved oxygen, pH, salinity, visibility, inorganic nitrogenous compounds (total ammonia nitrogen, nitrate, and nitrite), total dissolved solids, total suspended solids, settleable solids, and alkalinity were regularly done. Based on the 30-day data, these water quality parameters were within the desirable ranges except for the salinity during the first week of the experiment. Fifty percent of the water was changed to reduce the salinity to the desired level. In addition, data for the initial floc size revealed that flocs were usually within 10.01–48 μm² and above 500 μm².

In terms of growth performance, tilapia reared through polyculture in a biofloc system fed at 100 % satiation showed the highest average weight gain (AWG) at 41.83 g, followed by tilapia reared using the traditional method fed at 100 % satiation at 39.43 g, while the tilapia reared using the traditional method fed at 50–70 % satiation gained the lowest AWG at 39.96 g. A similar trend was reflected in absolute growth rates. As for GFP, however, AWG was also highest when reared with tilapia through polyculture in a biofloc system fed at 100 % satiation (1.95 g), followed by those reared in the same system fed until 50–75 % satiation (1.74 g). Traditional polyculture fed 50–75 % estimated satiation of tilapia (EST) showed the least promising results in relation to AWG for both species. However, descriptive analysis of these values is still ongoing.



A successful harvest of giant freshwater prawns and tilapia from the biofloc system setup at AQD Dumangas Brackishwater Station

Refining formulated feed for mangrove crab

In order to support the sustainability of the mangrove crab industry in Southeast Asia, there is a need to produce a cost-effective feed for these aquaculture species. Although SEAFDEC has started venturing into research with a focus on crab feed development, it was deemed necessary to work on further improvement of feed formulation with the inclusion of ingredients that are less expensive based on published nutritional requirements and physical properties of mangrove crab.

Refinement of feed formulation focused on partial replacement of fishmeal with cheaper ingredients such as mussel meat was tested in land-based tanks. Other ingredients such as cholesterol were added to the refined feed formulation to improve molting processes affecting the growth of the animal. The same diet has been assessed for its proximate composition, water stability, amino acid and fatty acid composition, digestibility of nutrients, attractability and palatability, and biological effects on the cultured mangrove crab.

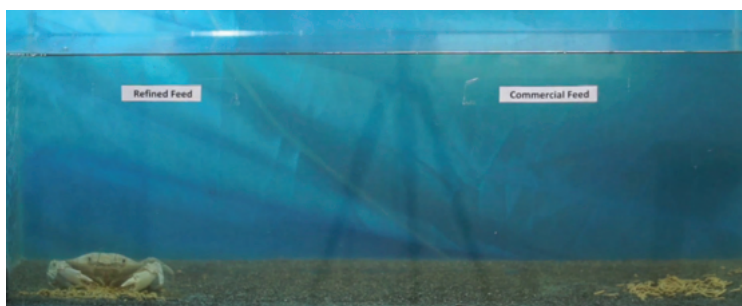
The refinement procedures produced a mangrove crab feed formula containing 51 % protein and 9 % fat. The said formula amounted to about PHP 116.00/kg (approximately USD 2.11/kg). Further evaluation of the same refined feed formula showed high water stability (54.30 %) even at the longest hour tested (24 h). Comparing the same feed with a commercial one did not show any significant difference in terms of feed water stability. Meanwhile, apparent nutrient digestibility coefficients for both refined and commercial feed were likewise examined. Results showed a comparatively higher apparent protein digestibility coefficient (APDC) for refined feed (93.70 %) than commercial feed (88.56 %). With regard to its apparent dry matter digestibility coefficient (ADMDC), no significant difference was detected between the refined feed (83.20 %) and commercial feed (81.60 %).

Attractability and palatability tests were done on both feeds utilizing two maze systems, the Y-maze and the rectangular maze. In the attractability test of the Y-maze, physical attraction was faster in the refined feed (approaching time: 14.75 min) compared to the commercial feed (approaching time: 20.13 min). In the case of the rectangular maze, the approaching time for refined feed was 0.38 min as compared to 38.75 min for the commercial feed. The palatability test, on the other hand, showed the same results for the Y-maze and rectangular maze systems. Consumption time was faster in refined formulated feed (204.03 min in the Y-maze, and 96.12 min in the rectangular maze). The commercial feed, however, was not totally consumed even after 6 h in both Y-maze and rectangular maze systems.

Three runs of the same experiment testing the refined formulated feed for mangrove crabs in land-based tanks showed a similar trend of results in terms of growth and survival rates. Feeding the mangrove crabs with 100 % refined feed yielded a significantly higher growth and survival rates as compared to 100 % feeding of either traditional feed (trash fish) or commercial feed.



Y-Maze set-up for the feed attractability for mangrove crab



Rectangular maze setup for the feed attractability for mangrove crab

Refinement of mangrove crab maturation diet

This new study, which started in the last quarter of 2022, aims to improve the reproductive performance of mangrove crabs by refining the broodstock maturation diet. The study started by formulating the crab maturation diet. Diets with varying combinations of protein and lipid levels were formulated and submitted for proximate composition analysis. The water stability of feeds was also tested, and based on the initial results, the feeds were revised to achieve a much more stable diet.

A trial formulation for the six proposed dietary treatments containing different protein/lipid combinations was prepared. The diets were assessed for stability and attractability. Initial results showed that formulated diets were 68.8 ± 0.94 to 88.08 ± 0.48 % stable at three hours and 49.79 ± 0.02 to 75.95 ± 4.90 % stable at six hours. Further refinements were made to improve the feed stability of the diet through the inclusion of synthetic binders.

A set of approximately 200 g crabs from AQD Dumangas Brackishwater Station were acquired to be used in assessing the diet. Initially, diet palatability showed that *S. serrata* broodstock continuously feeding on the diet within the 15-minute duration, suggesting that diets formulated were palatable to the test animals. The attractability and acceptability of the diet were observed under video surveillance. Furthermore, the attractability of the formulated diets with different protein and lipid combinations was also compared to that of the maintenance diet used in the hatchery. For this assessment, a Y-maze was set up with video surveillance. Additional crabs are being conditioned in modified crab trays for use in upcoming feeding experiments.



Mangrove crabs individually stocked in tray for conditioning to adapt to an experimental setup and wean to feed on full formulated diet

Polychaetes for black tiger shrimp maturation

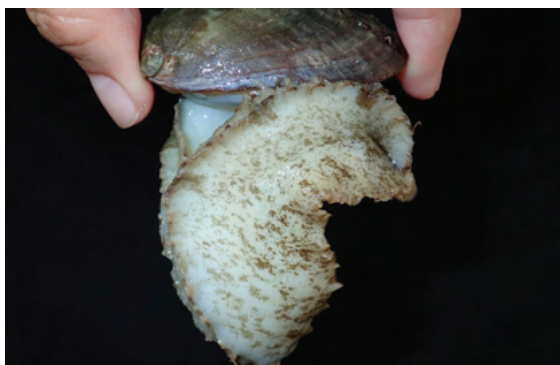
This study aims to verify the efficiency of polychaetes phospholipids in improving the reproductive performance of *Penaeus monodon*. The first part of the research was the extraction of polychaete polar lipid fraction (PLF). The polychaetes (*Marphysa* sp.) used were as sourced from the wild. A series of procedures, such as Bligh and Dyer lipid extraction, trichloroacetic acid (TCA) precipitation, concentration, and chilled acetone treatments, were carried out to produce the three extracts.

Polychaete extraction was one of the major activities accomplished this year. Fresh frozen polychaete was freeze dried and then subjected to Bligh and Dyer lipid extraction, concentrated in a rotary evaporator. The polar lipid fraction, mainly composed of phospholipids was then separated through cold-acetone precipitation. A 1,500 g frozen polychaete will yield approximately 4.70 g of phospholipid. Meanwhile, 150 g krill oil can yield about 2.43 g phospholipid. Extracted phospholipids were incorporated in shrimp formulated diets in two concentrations (0.25 and 0.50%). Feeds samples were submitted for proximate composition and fatty acid analysis.

In order to prevent bias in the experiments, the use of the same batch test animals is recommended. This study used its own hatchery-sourced animals for the experiment. The first run of the maturation experiment commenced on October 2022, where a total of 36 captive *P. monodon* female broodstock were subjected to eyestalk ablation. The test animals were divided into different dietary treatments, such as diets supplemented with 0.25 and 0.50 % polychaete polar lipid fraction and diets supplemented with 0.25 and 0.50% krill polar lipid fraction. Gonad maturation of broodstock was monitored regularly. Two more groups of animals were fed with basal diet and fresh frozen diet (polychaete, squid, and mussel) to serve as control groups. Due to limited available captive broodstock, the maturation experiment will be replicated over time. The second batch of test animals are currently weighing 57 g are conditioned to be used in the maturation experiment early next year. The ongoing laboratory and hatchery maturation activities will be continued in 2023.

Alternative diet for abalone grow-out

A study comparing seaweed (*Gracilariopsis heteroclada*) and formulated diet produced by AQD as feed for abalone in grow-out culture concluded in 2022. Preliminary results of initial experiments conducted in the previous years showed that abalone fed with the mixed diets (combination of seaweed and formulated diet) were significantly largest and heaviest than those fed with seaweeds, then formulated diet. The full report was published in Aquaculture Nutrition.



*Abalone fed with a mixed diet
(seaweed and AQD-formulated feed)*

This year, the last sampling was conducted on the 10th month of the culture period. The end of the experiments concluded similar results as the preliminary results. Abalone fed with mixed diets had significantly the highest mean shell length and body weight (45.90 ± 0.19 mm, 22.80 ± 0.31 g), followed by those fed seaweeds (43.47 ± 0.17 mm; 18.25 ± 0.26 g), and lastly, by those fed formulated diet (41.78 ± 0.18 mm; 15.76 ± 0.22 g). Mean growth rates, in terms of length and weight, were significantly higher when abalone were fed with mixed diets. Similarly, the survival rate was consistently high in mixed diet-fed abalone in one month from the start of culture until harvest.

Moreover, feed conversion ratios (FCR) were significantly lower in abalone fed with mixed diets and formulated diets compared with those fed seaweeds. The body weight to shell length ratios (BW:SL), which were the same in all treatments at the start of the experiment (0.19 g/mm), increased to 0.51/mm, 0.44/mm, and 0.38/mm in abalone-fed mixed diets, seaweeds, and formulated diet, respectively. Giving abalone a mix of formulated and natural diets was the best feeding regime based on the results of this experiment. Proximate analysis was conducted on abalone tissues pre- and post-conduct of the experiment.

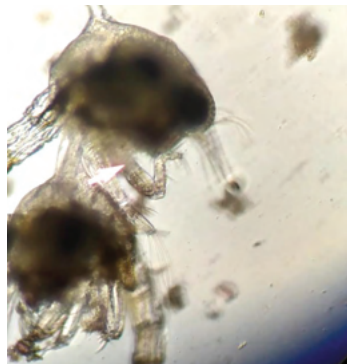
Microbound diet for mangrove crab larvae

Microbound diets (MBD), a formulated micro-particulate feed, are ideal food for larval rearing. It enables the modification of ingredients to match the nutritional requirements specific to various aquatic species. However, the sole use of MBD in the early larval stages of mangrove crabs has yet to succeed due to factors such as nutrient leaching, water pollution, and the absence of digestive enzymes. This new study aims to assess whether enzyme addition to MBD would improve the survival of mangrove crabs (*Scylla serrata*) zoea.

To commence the experiments, initial preparations of sample MBD were done. The feeding behavior of *S. serrata* zoea 1 was also observed in 2022. Results revealed that zoea 1 tended to approach areas in the water column where the food was (both rotifers and MBD), contrary to published generalizations that they encountered food by chance. The zoea 1 fed with MBDs was observed to usually be at the bottom where the feeds have sunk. Under microscope observation, zoeas were found to create a current to circulate the food toward them. Many MBDs were ignored by the zoea; however, a short clip was seen where an MBD particle seemed to be consumed by the zoea.

In addition, two pigments (chromic oxide and fluorescent Phloxin B) were incorporated in an MBD and assessed for their capability to be observed in the larvae's intestine to confirm ingestion. The Phloxin-dyed MBD gave a bright pink effect, which allowed for feeding observation under a brightfield microscope. A larger-sized MBD was grasped by the zoea during feeding; however, the food only stayed outside the mouth. Smaller MBDs that were embedded in a floc were also seen to be manipulated by the zoea. However, it was unclear whether the particles were ingested. Using a fluorescent microscope, no feeds were found in the zoea's intestines after two hours of feeding with a Phloxin-dyed MBD. This indicated that the feeds have not yet reached the intestine or that there was little to no ingestion of MBD. Unfortunately, 50 % larvae mortality occurred after two hours of exposure to the dyed MBD.

Based on these observations, the methods will be adjusted to improve the results, including the application of other fluorescent dyes, the use of different binders, and the modification of feeding time. The study will continue in 2023.



Feeding of mangrove crab zoea 1 using Phloxin-dyed MBD (left) and Phloxin-dyed MBD embedded in bioflocs (right)

2.4 Development of responsible and sustainable aquaculture technologies

Through its Departmental program on “**Maintaining Environmental Integrity through Responsible Aquaculture**,” AQD continued developing environment-based aquaculture technology by integrating environmental factors into its research activities and maintaining environmental integrity by promoting responsible aquaculture practices. The activities undertaken in 2022 were as follows:

- *Abalone*

In 2022, a study was conducted to scale up abalone culture using recycled containers (drums) and compare the growth and survival rates with those cultured in PVC tubes. The study had three main objectives which were to 1) determine the growth and survival of the abalone reared in large, recycled containers, 2) determine the growth and survival of the abalone reared in PVC tubes, and 3) compare the economics in producing abalone using different containers.

The study commenced with site selection, fabrication of the recycled containers, and feed preparation. A bamboo raft to hold 10 containers was constructed and abalone juveniles were transported to the site and stocked. Feeding rates and schedules were established and monthly sampling was done. By the fourth quarter of 2022, five monthly samplings have been done, and the results showed that both monthly mean shell length and body weight were significantly higher in abalone cultured in pipes than those in recycled drums. Additionally, survival was higher in PVC pipes than in drums, with significantly higher survival rate recorded during the last sampling in November 2022.



Bamboo raft from where culture containers are being suspended 10 m deep



Pre-weighed abalone feeds in designated, labeled containers

- *Anguillid eels*

An attempt was made in 2022 to identify tropical anguillid eels in selected natural habitats in the Philippines using environmental DNA (e-DNA) assay. The e-DNA analysis is used in detecting the presence of species in known and unknown aquatic habitats without the need for obtaining actual biological samples. The method is based on the assumption that species-specific e-DNA or DNA that organisms shed into the aquatic environment (in the form of cells or tissue) can be analyzed from water samples using molecular techniques.

To identify other natural habitats in Southern Luzon where anguillid eels thrive, the e-DNA method was first successfully optimized and confirmed to work using water samples from eel culture tanks at the AQD Binangonan Freshwater Station. Initial active samplings along the Cagayan River failed to detect eel e-DNA. Consultation with Tohoku University led to a shift from active to passive sampling by means of an improvised water sampling grid with membrane filters set up for 12–24 h in the sampling sites. Results from the December 2022 field sampling showed positive results from those collected passively in Aparri, but not in Baggao along the Cagayan River. This indicates that anguillid eels at the time of sampling, were present in Aparri while these were absent in Baggao. Protocol modifications were made and included in two proposed manuals on eel species identification using conventional morphometric methods and the more advanced DNA and metabarcoding methods.



Passive sampling at Aparri using an improvised sampling grid with membrane filters

- *Sea cucumber*

To determine the optimal microalgae species and combination in larval rearing of sandfish in the hatchery, microalgae experiments were done using SEAFDEC/AQD PrimoAlga *Chaetoceros calcitrans*. Based on preliminary 12-day data, sandfish stocked at 200 individuals/l following feeding progression 2 (day 2–6: 10,000 cells/ml, day 7–12: 20,000 cells/ml, and day 13 onwards: 10,000 cells/ml) and fed twice daily at 9:00 a.m. and 4:00 p.m. achieved that highest growth rate.

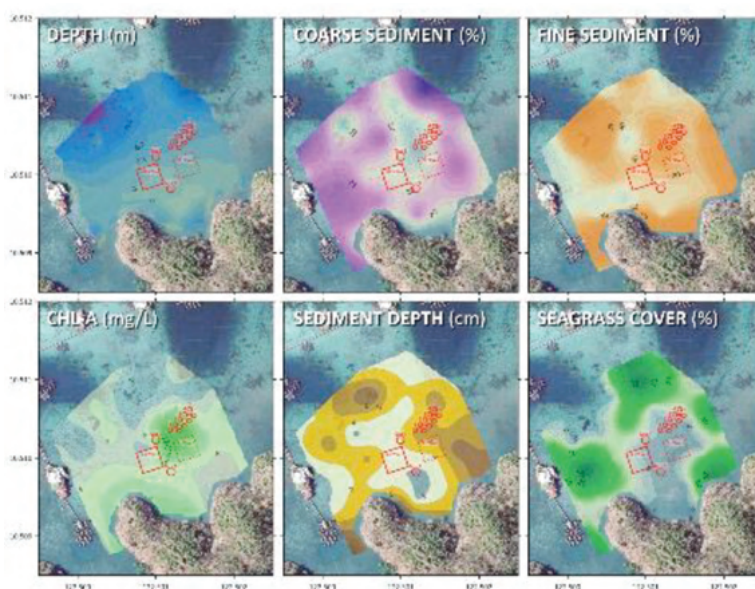
The influence of biofilm in ocean nursery production of early juvenile sandfish was assessed. A floating nursery was set up at the AQD Igang Marine Station and stocked with sandfish spats in 12 nursery *hapas*. Biofilm samples were collected and investigated. Initial 30-day data showed that the average wet body weight was 1.0 g with a survival rate of 28 %.

At the Molocaboc island-based hatchery, 1,600 very early-stage juveniles and 50,000 doliolaria stage larvae sandfish were stocked to demonstrate the use of SEAFDEC/AQD PrimoAlga as the only natural larval food. From this, 3,651 early juvenile sandfish were successfully harvested and stocked into a floating hapa nursery site. This was done completely by trained partners from the local Molocaboc Sea Ranchers Association (MOSRA). In September 2022, two family beneficiaries were awarded sandfish spats (2,800 pcs per family) which they will manage exclusively. The families were initially trained in stocking, monitoring, sorting, change of nets, and regular check-up.

As part of mitigating natural predation, the effect of shelters and shading on the burying behavior and preference of sandfish juveniles were investigated. It was found that shading and shelters were useful factors to consider in designing predator-mitigation systems. After 45 days, results indicated that sandfish preferred to bury around the corners of culture tanks that were shaded. There was also a significant preference to bury where artificial shelters were placed.

A separate experiment compared “fresh” pens, wherein sandfish were transferred into new pens every month, and “prolonged-use” pens, where they were restocked into the same pens every month. Preliminary results showed that the type of pen did not affect sandfish growth rate until the ninth month when sandfish from the “fresh” pens became bigger.

To assess the biophysical parameters that influence sandfish growth in a sea ranch, a detailed assessment was done at the AQD Igang Marine Station sea ranch site. At the Sagay Marine Reserve site, a bathymetry profiling was done to locate potential expansion sites for sea ranching. Four potential grow-out sites in Molocaboc were assessed. Two expansion sites for grow-out were identified based on the biophysical and socioeconomic criteria. In July 2022, two experimental grow-out pens were constructed in each of the expansion sites. Monitoring of sandfish growth and survival rates is ongoing.



Some biophysical profiles at the AQD Igang Marine Station sandfish ranch site

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

In 2022, AQD continued to carry out activities under its Departmental Program “**Meeting Socio-economic Challenges in Aquaculture**” with the aims of implementing socioeconomics 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 and freshwater areas. The activities undertaken in 2022 were as follows:

Community-based sea cucumber sea ranching

In 2022, a study funded by the Australian Centre for International Agricultural Research (ACIAR) was done to assess the capacity of island-based communities to pursue a sea cucumber farming livelihood. The study also aimed at developing strategies to improve the participation of fishing communities in the farming of sandfish (*Holothuria scabra*), specifically in the intertidal flats of Barangay Molocaboc in Sagay City, Negros Occidental. A multi-method approach combining qualitative and quantitative data collection was applied.

Moreover, community awareness regarding the local policies and regulations, particularly on the sandfish trade, was improved through these participatory activities. Dialogues were made with the local traders to discourage purchasing fresh undersized (< 320 g) sandfish. Furthermore, a Barangay resolution was drafted defining the sandfish farming zones.

A 400-m² pilot expansion site, “Kang-atong,” was identified using a selection site index developed collaboratively with the stakeholders. Sandfish juveniles (> 150 g) were released in the pen at the site and closely monitored. Meanwhile, nursery floating “*hapas*” were co-managed by two families of MOSRA. After two months, the sandfish juveniles were released in the sea ranch. MOSRA also harvested 24 pieces (> 320–600 g) of sandfish to demonstrate traditional processing or drying. The 3.2 kg fresh de-gutted sandfish yielded a final dried sea cucumber of 260 g.



Locals installing a sandfish culture pen in a pilot expansion site, Kang-atong



Demonstration of harvesting, processing, and drying of good size (> 320 g) sandfish

Hatchery, nursery, grow-out operations, harvesting and processing, fabrication, and installation of floating *hapas* were done. Meetings, educating community residents about collecting and trading sandfish, and recruiting new members, particularly women, for MOSRA were done regularly alongside regular sandfish culture activities.

Giant freshwater prawn aquaculture for livelihood

With support from the JTF, a study is being conducted to promote community-based sustainable aquaculture livelihood (CBSAL) project at Binangonan, Rizal through a tri-party collaboration between fishers, local government, and AQD.

By the end of 2022, the study achieved several milestones, the foremost of which was the signing of the memorandum of understanding between the collaborators. Additionally, a usufruct agreement with the landowner of the hatchery site enabled the construction of a small-scale hatchery accessible to members of the Pipindan Aquaculture Producers Association (PAPA). PAPA members were trained in breeding and producing giant freshwater prawn (*Macrobrachium rosenbergii*) post-larvae at AQD Binangonan Freshwater Station pending the completion of the hatchery. During the Training, PAPA reared 12,828 post-larvae with 29.5 % of it sold by the end of 2022. Delays in the provision of utilities for the small-scale hatchery, inclement weather, and learning curve of PAPA trainees limited the production for the year.



Daily hands-on training of members of Pipindan Aquaculture Producers Association on rearing of prawn larvae



Interior of the newly constructed giant freshwater prawn hatchery

The study also initiated a market-linking field trip which was done to develop the value chain of giant freshwater prawn. The next step was to collect growth and economic data from grow-out farms.



Project collaborators stocking prawn juveniles in Calauan, Laguna

2.6 Collaborative projects with the Philippine Government

AQD has developed and verified five decades' worth of research and technologies on aquaculture, including broodstock management, seed production, and grow-out of economically-important finfishes, crustaceans, mollusks, and seaweeds. 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 to accelerate the transformation of these matured technologies to become economically-viable models which can help enrich the livelihood and food security of fisherfolks in the Philippines. The activities and achievements under this Program in 2022 were as follows:

Fry sufficiency program

This collaboration project with the Department of Agriculture-Bureau of Fisheries and Aquatic Resources (DA-BFAR) aims to find a solution to the problem of seed insufficiency in the Philippines by constructing and operating more hatcheries, rehabilitating unproductive hatcheries, and enhancing the performance of milkfish breeders. In 2022, AQD focused on two main components, the creation of feasibility studies for legislated hatcheries and revival of abandoned hatcheries across the country.

For legislated hatcheries, about 48 hatcheries were needed to realize this program, and each hatchery would need to produce 25 million fry per annum. These proposed hatcheries would need about 3,750 milkfish breeders: 2,500 females and 1,250 males, following the ratio of 2 females to 1 male. Apart from solving the scarce fry supply, the program would also try to break the stigma that captive-bred fry are inferior to wild-caught fry in terms of growth, morphology, and survival, as DA-BFAR would ensure that the fry produced would be of the highest quality. Aside from milkfish, these proposed hatcheries are versatile enough to accommodate the culture of other economically important aquaculture species such as black tiger shrimp (*Penaeus monodon*), mangrove crab (*Scylla serrata*), and other commodities that are quickly gaining in popularity, e.g. pompano (*Trachinotus blochii*).

In 2022, three feasibility studies were completed by AQD for legislated hatcheries. The process includes assessing the suitability of pre-identified project sites, identifying the most suitable site, and developing feasibility study report and other relevant documents.

Out of the 16 proposed hatcheries agreed upon by AQD and DA-BFAR in 2018, the following have progressed from feasibility studies to actual construction, including in Lingig, Surigao del Sur (RA 10787), Sultan Naga Dimaporo, Lanao del Norte (RA 10860), Jabonga, Agusan del Norte (RA 10813), Del Carmen, Surigao del Norte (RA 10825), Hinatuan, Surigao del Sur (RA 10944), and Jose Dalman, Zamboanga del Norte (RA 10859).

In addition, feasibility studies are being conducted for hatcheries supported by house bills in Western Visayas. Five feasibility studies were completed in Iloilo Province (Batad, Carles, and Concepcion), Negros Occidental (Talisay City), and Antique (Tibiao). Outside Western Visayas, another feasibility study was completed for Basilisa, Dinagat Islands.

		FS PHASE	CONSTRUCTION PHASE
RA 10787	Unging, Surigao del Sur	FS was done by AQD	97.26%
RA 10825	Surigao City, Surigao del Norte	FS was done by AQD	8.54%
RA 10825	Del Carmen, Surigao del Norte	FS was done by AQD	32.5%
RA 10813	Iabanga, Agusan del Norte	FS was done by AQD	91.58%
RA 10945	Perez, Quezon	FS was done by AQD	PHASE 1: 100%
RA 10858	Nasipit, Agusan del Sur	FS was done by DA-BFAR CAGADA	0.00%
RA 10944	Mihauan, Surigao del Sur	FS was done by AQD	32.3%
RA 10860	Sultan Naga Dimagror, Lanao del Norte	FS was done by AQD	PHASE 1: 100%
RA 10859	Jose Dalman, Zamboanga del Norte	FS was done by AQD	25.98%
RA 10856	Bantayan, Cebu	FS was done by DA-BFAR 2	85.0%
RA 10939	Almonan, Quezon	FS Pending	0.00%
RA 10948	Guisyangan, Quezon	FS was done by Guisyanigan IDU	55.0%
RA 10950	Iligan, Iligan	FS was done by DA-BFAR 3	77.0%
RA 10938	Lopez, Quezon	FS Pending	0.00%
RA 10940	Gumaca, Quezon	FS Pending	0.00%
RA 10947	Plaridel, Quezon	FS was done by Plaridel IDU	98.0%

Status of legislated hatcheries assigned to AQD (from the agreement between AQD and DA-BFAR in 2018 as of November 2022)

For reviving abandoned hatcheries, improvements were made in two hatcheries: Batad, Aklan, and Concepcion, Iloilo. Improvements for Batad, Aklan includes repairs of tanks and training of hatchery personnel in culturing algae and natural food. AQD also donated larvae onsite to jumpstart the rearing process. For the one in Concepcion, Iloilo, repairs of tanks and maintenance of natural food cultures are ongoing.

Development of cost-efficient feeds

AQD made it a mission to rely less on fish-based ingredients, such as fishmeal and fish oils, to lower the cost of feed prices and improve the profitability of fish farms in the Philippines. For the past years, AQD partnered with DA-BFAR and National Fisheries Research and Development Institute (NFRDI) in identifying and utilizing feed ingredients that are cost-effective and can be used as alternatives to fishmeal. In 2019, a feed formulation for tilapia and milkfish was developed (**Table 2**). The cost of producing the said formulated feed was relatively lower than the price of most commercial feeds in the country.

To test the effectiveness and efficiency of the feed, AQD conducted seven verification runs in BFAR techno-farms and selected private fish farms in different parts of the country from 2019 to 2021. All results showed that feeds formulated by AQD performed better against the commercial feeds, specifically in terms of size and average body weight (ABW) of both tilapia and milkfish.

Following this, the Project is now moving towards technology adoption. The formulated feed was given to prospective cooperators through the “Aquafeed Research, Development, and Extension Project” with DA-BFAR and NFRDI. The first in-farm and actual demonstration of the formulated feeds was conducted for tilapia in a freshwater pond in Santo Tomas, Nueva Ecija. Results of the demonstration resulted in 1.9 t of harvest after 146 days of culture. Another freshwater culture run was conducted in Taal Lake which yielded another 1.9 t of tilapia. Both runs achieved an FCR of 1.29.

Table 2. Feed formulation of the low-cost diet for tilapia and milkfish

Ingredients	Tilapia (% ingredient)	Milkfish (% ingredient)
Danish fish meal	0.75	1.00
Sardines fish meal	1.50	2.00
Poultry by-product meal	9.00	12.00
Defatted soybean meal	15.00	18.00
Distiller's dried grains solubles (DDGS)	12.00	10.25
Acetes	-	0.50
Wheat pollard	5.00	5.00
Bread flour	12.50	12.00
Soybean oil	0.75	1.00
Danish fish oil	0.75	1.00
Vitamin mix	0.05	0.05
Vitamin C	0.05	0.05
Rice bran	25.60	24.10
Protein enhanced copra meal (PECM)	17.00	13.00
BHT, butylated hydroxytoluene	0.05	0.05

More collaborators are in line for this technology-transfer program, including farms in Santo Tomas in La Union, Lala in Lanao del Norte, Roxas City in Capiz, and San Rafael in Iloilo. The farms in San Rafael, Iloilo, and Roxas City, Capiz were already assessed by AQD. Activities will begin in 2022 and continue until 2023.

Sufficient feed production is a critical factor that affects efficient hatchery production. With this, AQD proposed the establishment of a feed mill plant for the production of cost-effective feeds for commercially-viable finfishes. A PHP 30 million (approximately USD 550,000) budget, funded by BFAR Region VI was approved to construct feed milling plants in different parts of the country, including one to be located in SEAFDEC/AQD. The proposed feed mill plant will have a 30 t/day capacity and will produce all types of feed for commercially-important aquatic species.



Proposed location of the feed mill plant to be constructed within the SEAFDEC/AQD compound at Tigbauan, Iloilo, Philippines

Oplan Balik Sugpo (Operation Black Tiger Shrimp Revival)

Seeking a solution to the declining production of black tiger shrimp, AQD partners with DA-BFAR with the goal of reviving the million-dollar industry back to its former glory. The program highlighted two efforts to successfully revive the prawn industry in the Philippines: the production of high-quality *Penaeus monodon* postlarvae (PL) and improved grow-out culture.

In the hatchery phase, the Shrimp Hatchery Complex (SHC) located at the Tigbauan Main Station of AQD was built and utilized to produce black tiger shrimp fry. It is composed of a spawner/broodstock facility used as a quarantine area for the pathogen detection of newly-arrived spawners. The shrimp hatchery often utilizes spawners from the wild which are processed and analyzed after spawning to determine the presence of pathogens. Wild spawners are acclimatized and disinfected prior to stocking and spawning. Newly-spawned eggs are washed with UV-sterilized seawater and disinfected to lessen pathogens that stick to the capsules of the eggs, thereby limiting pathogen ingestion by the nauplii when their mouths begin to open. Harvesting of the nauplii is based on the PCR test results of the spent spawners. Pathogen-negative postlarvae are separated from pathogen-positive nauplii and stocked in two different larval-rearing modules in the shrimp hatchery.

All nauplii are reared, fed, sampled, and monitored until they reach the PL stage. Influent water undergoes a series of filtration systems to ensure good water quality for the stocks. Seawater from the source first passes through the sand filter before it reaches the reservoir. From the reservoir, the water passes through the rapid sand filter, then through the UV sterilizer before it reaches the larval rearing or natural food tanks. Filter bags with 5 µm mesh size are also installed at every seawater outlet.

Strict biosecurity measures are being implemented at the spawner/broodstock facility and shrimp hatchery as part of the standard operating procedures. The staff are required to shower and change into scrub suits and hatchery slippers or boots upon entering the facility to avoid disease occurrence. Footbaths, hand sanitizers such as alcohol, and disinfectants are also provided at every entrance point. PCR tests are conducted at the PL 5, 10, and 15 stages to monitor the health condition of the shrimp fry before harvest.

Fry harvesting was done when they reached PL 15–PL 20. In 2022, the SHC produced 600,000 disease-free and good-quality *Penaeus monodon* fry. Some of these were stocked on the Dumangas Brackishwater Station (DBS) ponds and at the HDPE-lined ponds of NFRDI in Brgy. Butong, Taal, Batangas, for verification purposes. The remaining fry were sold to local buyers who wished to purchase the fry at PHP 0.20–0.25 (USD 0.0037–0.0046) per piece.

As for the grow-out phase, AQD collaborated with the NFRDI to conduct demonstration runs of the environment-friendly culture protocols aside from the verification runs conducted at Dumangas Brackishwater Station.

Four 500 m² HDPE-lined rectangular grow-out ponds and one 2,000 m² HDPE-lined reservoir pond located at NFRDI Freshwater Fisheries Research and Development Center

in Brgy. Butong, Taal, Batangas were utilized for the grow-out culture of black tiger shrimp. The operation adopts environment-friendly schemes in shrimp farming through proper biosecurity measures and the use of biomanipulators.

Over 600 pieces of tilapia and milkfish fingerlings were stocked at the reservoir pond. The fingerlings serve as biomanipulators for the greenwater technology and limit the accumulation of luminous bacteria in the grow-out ponds. The culture areas are secured from predators by a perimeter fence and bird scare and stocked with high-quality, and disease-free PL produced at AQD SHC in Tigbauan, Iloilo. The verification run lasted for five months and harvested a total of 659 kg of good quality shrimps with 26 g ABW.

Meanwhile, another verification run is also being implemented at DBS using soil-based ponds: 1) 8,139 m² and 2) 5,401 m². Approximately 125,000 fry were stocked in Pond 1 and 81,000 fry in Pond 3, with a stocking density of 15 fry/m². After 80 days of culture (DOC), fry in Pond 1 gained an ABW of 13 g and an 85 % survival rate. For Pond 3, the fry reached an ABW of 30 g and a 94.11 % survival rate after 125 DOC.

Currently, AQD continues to make progress in brackishwater culture in its Dumangas Brackishwater Station. Upon collection of substantial data, aquaculture extension manuals on *P. monodon* hatchery operations and grow-out culture in brackishwater ponds will be published.

In 2022, a newly built shrimp broodstock facility in AQD Tigbauan Main Station in Iloilo started its operations. AQD will use the facility to jumpstart another area for research in establishing protocols in breeding Specific Pathogen Free (SPF) shrimp breeders.

Accelerated Technology Transfer

There had been a weak linkage between the scientific development of aquaculture technologies and fish farmers. AQD, together with its partner agencies in the government, aims to accelerate technologies through technology caravans, on-site and hands-on training courses, and field demonstrations.

From 2019 to 2021, a total of seven hands-on and on-site training courses were conducted in different parts of the Philippines. Two of which were conducted online during the height of the COVID-19 pandemic. Topics, which were requested by the beneficiaries in the local government units, include the biology and ecology of the cultured species, hatchery-to-grow-out operations of freshwater and marine species, diseases, nutrition, biosecurity measures, and others. For on-site training courses, practical sessions were conducted on various culture techniques, including demonstration of proper water quality monitoring in ponds and cages and feed preparations, among others.

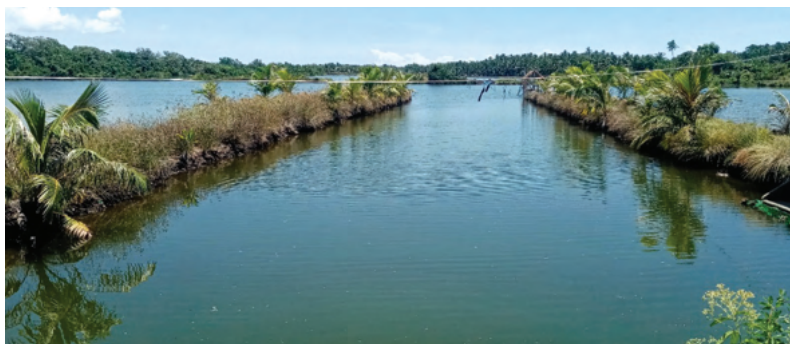
For 2022, a course on grow-out operations of black tiger shrimp was conducted upon the request of the NFRDI last October at Brgy. Butong, Taal, Batangas. The course was conducted to share the technologies developed through the *Oplan Balik Sugpo* program. It focused on sharing information on how AQD implemented the program from the production of disease-free and high-health shrimp fry in the hatchery, appropriate techniques applied

in the grow-out phase, and how biosecurity measures were incorporated in every step of the operation. Twelve participants, composed of their Senior Science Research Specialists, Science Research Assistants, farm workers, and aquaculture technicians, attended the training.

Aside from conducting training courses to relay science-based aquaculture technologies, this technology transfer program aims to partner with aquaculture farms to demonstrate matured aquaculture technologies developed by AQD through training of farm owners and technicians for them to be able to adapt and conduct operations independently.

In 2022, AQD conducted site assessments of the four provinces of Western Visayas, including Negros Occidental, Capiz, Aklan, and Antique. These areas were assessed on their suitability for the brackishwater pond grow-out culture of mangrove crab and pompano. In order for the site to be suitable, it should have a manageable pond with an area of not more than 1 ha, good water quality, good water exchange, accessible for delivery of inputs (feed, fry, and fertilizers), and, most importantly, available electrical power supply for the life support systems, such as pumps and paddlewheels.

Among the assessed sites, a site in New Washington, Aklan, was found to be suitable for the grow-out culture of pompano in brackishwater ponds. Meanwhile, a site in Hamtic, Antique turned out to be suitable for the grow-out of mangrove crabs which has the presence of earthen mounds with mangroves that are beneficial for the crabs. Currently, these farms are undergoing repairs and the field demonstrations will start in the first quarter of 2023.



Selected pond site for pompano grow-out in New Washington, Aklan



Site for mangrove crab grow-out in Hamtic, Antique

Manpower Development

In 2018, 16 graduates from different fisheries schools in Western Visayas were trained during the “Training Course on Manpower Development on Shrimp, Marine Fish, and Tilapia Aquaculture” to enhance their capabilities and broaden their perspectives and experiences in terms of aquaculture. They were trained in shrimp and multispecies marine fish hatchery operations and cage and brackishwater pond culture operations. After three months of intensive training, they were employed by AQD and were assigned to the different areas and hatcheries at Tigbauan Main Station.

Following the COVID-19 pandemic, another batch of trainees underwent intensive training courses related to fisheries and aquaculture in 2021. The four graduates from different fisheries schools in Mindanao and Bicol area were previously screened and interviewed by AQD. They were exposed and trained rigorously on shrimp, marine fish, mangrove crabs, giant freshwater prawns, oysters, and seaweed culture, as well as on the operations of brackishwater ponds and cages. Currently, they are assigned at AQD Multi-Species Marine Fish Hatchery, Oyster Hatchery, and Mangrove Crab Hatchery.

As part of their duty to provide technical assistance in hatchery operations, Manpower Development personnel from the first batch were deployed to train the staff on natural food production in a rehabilitated milkfish hatchery in Songculan, Batan, Aklan last March to April of 2022. Also, one of the graduates helped in the natural food production and hatchery operations of a privately-owned milkfish hatchery in Dumangas, Iloilo last February 2022.

To update the technical knowledge of these staff, they underwent hands-on training on feed mill operations and management at AQD Feed Mill facility from March to October 2022. The training consisted of familiarization with the equipment, feed formulation, and feed production, among others.

The search for the potential third batch of the Manpower Development course started last November 2022. Four graduates of the Bachelor of Science in Fisheries from the University of the Philippines Visayas have passed and were accepted to attend the course. They will undergo the same training as the previous batches for over 100 days. Monitoring of their performances is currently ongoing and the evaluation will soon follow.

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 Southeast Asian 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 a need to develop good handling practices and build competencies on new preservation technologies. Rapid deterioration of quality due to irreversible processes such as microbiological metabolism, oxidative reactions, and enzymatic activity takes place soon after the capture and/or harvest of seafood. In order to safeguard the freshness and safety of seafood products and extend their shelf life and maintain their nutritive quality and economic value from catch to consumer, good handling practices and technologies are crucial.

Specifically for seafood 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. In addition to 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 seafood 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 the sauce.

To introduce such technologies for possible adoption by countries in the Southeast Asian region, MFRD embarked on the project “**Enhancing Food Safety and Competitiveness of Seafood Products.**” The duration of this Project is from 2020 to 2024 and comprises 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 seafood such as sushi and sashimi and serve to strengthen regional capabilities in the safe handling of high-risk seafood products, as well as allow the Member Countries to gain knowledge about new preservation technologies, enhancing the value, safety, and quality of seafood products.

In 2022, the local consultant from the Institute of Higher Learning (IHL) of Singapore continued to develop training materials for GMP & GHP for Ready-To-Eat Raw Fish and Fishery Products in line with the scope defined at the Project Inception Meeting held in 2020. The training “GHP-GMP for RTE Fish & Fishery Products” was then conducted for

the Member Countries on 8 April 2022, followed by one-year pilot trials in the respective countries. It was expected that the pilot trials would be completed by the second quarter of 2023.

ASEAN-JICA Food Value Chain Development Project

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 activities to be implemented by SEAFDEC are under the third thematic area to support the fisheries sector in achieving the expected output, *i.e.* food safety in the fishery sector is improved by the promotion of GAqP and development of ASEAN guidelines and relevant principles on fisheries inspection mechanism.

Although this ASEAN-JICA Project was approved by the SEAFDEC Council in 2021 to be implemented by SEAFDEC in 2022 provided that the fund could be secured, the administrative process in Japan in preparation for the Project has been delayed due to the COVID-19 situation in 2021–2022. According to JICA’s project preparation procedures, a study was initiated in 2022 and currently being carried out by JICA as the Project Implementation Agency to prepare the Project activity details (*i.e.* sub-activities and budget allocations). The study results will be further discussed and confirmed between JICA and ASEAN Secretariat. Therefore, in 2022, the planned sub-activities and budget allocations have not yet been finalized and confirmed; and it is expected that the Project activities could commence in 2023.

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

In 2022, 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

The activities of the project “**Assistance for Capacity Development in the Region to Address International Fisheries-related Issues**” have been carried out by the SEAFDEC Secretariat funded by the Japanese Trust Fund with the duration from 2020 to 2024. The Project aims to monitor the emerging international fisheries-related issues and provide regional platforms for the AMs to raise awareness of the emerging international fisheries-related and trade-related issues discussed at various international fora (*e.g.* ASEAN, FAO, UN, 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 in the form of regional common/coordinated positions and

recommendations for national and regional action plans to safeguard the interest of the fisheries sector of the countries in the region.

One of the events scheduled in 2022 was the “19th Meeting of the Conference of the Parties (CoP) to CITES” or CITES-CoP19. In preparation for this event, SEAFDEC representatives attended the “74th Meeting of the Standing Committee of the CITES” on 7–11 March 2022 in Lyon, France which discussed and reviewed the strategies, policies, and species-specific matters affecting the Convention’s implementation, including aquatic species, such as sharks and rays, eels, seahorses, queen conch, and precious corals, that would be further discussed at the CITES-CoP19. Another important preparatory work of SEAFDEC prior to the CITES-CoP19 was the “Regional Technical Consultation (RTC) on Development of the ASEAN-SEAFDEC Common Positions on the Proposed Listing of Commercially-exploited Aquatic Species (CEAS) into the CITES Appendices” organized by the SEAFDEC Secretariat on 30 August–1 September 2022 in Bangkok, Thailand. During the RTC, the discussion focused on the technical information and views of countries on the proposed listing of CEAS into the CITES Appendices, *i.e.* *Carcharhinidae* spp., *Potomotrygon* spp., *Rhinobatidae* spp., *Sphyrnidae* spp., *Thelonota* spp., and *Hypancistrus zebra*. Although the RTC was not able to come up with common positions for each of the proposals, the RTC developed the “Positions of the ASEAN-SEAFDEC Member Countries on the Proposed Listing of Commercially-exploited Aquatic Species (CEAS) into the CITES Appendices at the CITES-CoP19” which was submitted to the SEAFDEC Council *ad referendum*.

On 14–25 November 2022, SEAFDEC representatives participated in the “19th Meeting of the Conference of the Parties (CoP) to CITES” in Panama City, Panama. SEAFDEC also supported the representatives from fisheries authorities of some AMSs to participate in the CITES-CoP19. At this event, 52 proposals for the inclusion of species of animals and plants into Appendix I and II of CITES were put into the discussion. As part of the CITES-CoP19, SEAFDEC also convened the side event “Resource Utilization of Commercially-exploited Aquatic Species (CEAS) in Southeast Asia: Regional Cooperation to Support National Actions” on 18 November 2022. The side event was intended to share the experiences of SEAFDEC including regional initiatives and lessons learned in supporting the ASEAN-SEAFDEC Member Countries through the implementation of capacity-building programs on the identification of sharks and rays, and the conduct of a study on the market and trade of sharks including the major actors, market channels, practices, and utilization, to support sustainable development and management of shark and ray resources in the Southeast Asian region. The positions of the ASEAN-SEAFDEC Member Countries adopted during the RTC were also shared during the side event. As a result of the CITES-CoP19, all proposals for CEAS were supported by the CITES Parties for inclusion in the CITES Appendices, namely: *Carcharhinidae* spp., *Sphyrnidae* spp., *Rhinobatidae* spp., *Thelonota* spp., and *Potomotrogonidae* spp. were adopted for inclusion in Appendix II, while *Hypancistrus zebra* which was proposed for Appendix I was finally adopted to be included in Appendix II.



19th Meeting of the Conference of the Parties to CITES on 14–25 November 2022 in Panama (top) and SEAFDEC side event “Resource Utilization of Commercially-exploited Aquatic Species (CEAS) in Southeast Asia: Regional Cooperation to Support National Actions” on 18 November 2022 (bottom)



In 2022, SEAFDEC shared the updated information on several fisheries-related issues at the virtual ASEAN annual meetings, *i.e.* 14th Meeting of the ASEAN Fisheries Consultative Forum (14th AFCF) and 30th Meeting of the ASEAN Sectoral Working Group on Fisheries (30th ASWGF), which were hosted by Indonesia on 21 and 22–23 June 2022, respectively. During these two Meetings, SEAFDEC provided updates on the progress of the activities on fisheries priority areas, namely: fishing capacity and zoning system, securing sustainable small-scale fisheries, resource rehabilitation and enhancements, impacts of climate change on fisheries, combating IUU fishing, and traceability of fisheries and aquaculture products. During the ASWGF Meeting, a number of AMSs also expressed their appreciation to SEAFDEC for sustaining the cooperation with the AMSs, especially the financial support of the Government of Japan through the Japanese Trust Fund which had contributed to enhancing the capacity of the respective countries in promoting sustainable development of the fisheries sector.



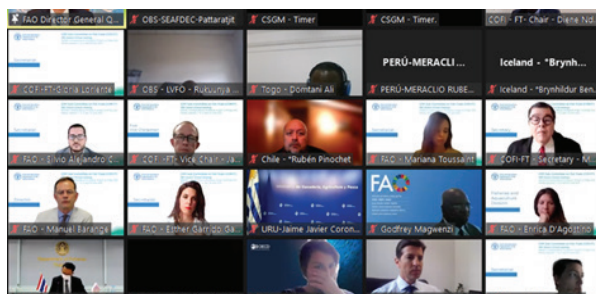
14th AFCF and 30th ASWGF organized through the virtual platform with the participation of SEAFDEC

In addition to the participation at the ASEAN fora, SEAFDEC also attended and provided technical inputs at various international events that discussed international fisheries-related issues aimed at achieving sustainable development of fisheries of the region. These include:

- 36th Session of the FAO Regional Conference for Asia and the Pacific (APRC) on 8–10 March 2022 in Dhaka, Bangladesh and online
- SDG14 Roundtable: Conserve and Sustainably Use the Oceans, Seas, and Marine Resources for Sustainable Development organized by UNESCAP on 28–30 March 2022 in Bangkok, Thailand and online)
- Virtual East Asia Summit (EAS) Workshop on Illegal, Unreported, and Unregulated (IUU) Fishing organized by Singapore and India on 12–13 April 2022 through the online platform
- FAO Technical Consultation on Voluntary Guidelines for Transshipment organized by FAO on 30 May–3 June 2022 in Rome, Italy and online
- 18th Session of the Sub-Committee on Fish Trade of the Committee on Fisheries (18COFI:FT) organized by FAO on 7–9 and 20 June 2022 through the online platform
- 2022 United Nations Conference to Support the Implementation of Sustainable Development Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development organized by UN on 27 June–1 July 2022 in Lisbon, Portugal
- 9th Meeting of Regional Fishery Body Secretariats Network organized by FAO on 2–3 and 9 September 2022 in Rome, Italy and online
- 35th Session of COFI organized by FAO on 5–9 September 2022 in Rome, Italy
- 3rd Meeting of the Sustainable Ocean Initiative Global Dialogue with Regional Seas Organizations and Regional Fishery Bodies organized by ISSD on 25–28 October 2022 in Busan, Republic of Korea
- Dialogue on Illegal, Unreported and Unregulated (IUU) Fishing organized by the Asia-Pacific Development, Diplomacy & Defence Dialogue (AP4D) on 19 October 2022 through the online platform



2022 United Nations Conference to Support the Implementation of SDG14 on 27 June-1 July 2022 in Lisbon, Portugal



18th Session of the COFI Sub-Committee on Fish Trade on 7–9 and 20 June 2022

Another important fish trade-related issue is the fishery subsidies which have been under negotiation by the World Trade Organization (WTO) members for two decades. In 2022, the WTO members finally adopted the “WTO Agreement on Fisheries Subsidies” during the 12th Ministerial Conference (MC12) held on 17 June 2022 in Geneva, Switzerland. The adoption of this Agreement was in line with SDG 14.6 which mandated the WTO to negotiate disciplines to eliminate subsidies contributing to IUU fishing and overfishing, taking into account the needs of developing country members. In response to this new Agreement, SEAFDEC was tasked by the SEAFDEC Council to build the capacity of the Member Countries to determine the reference points of the stock status for proper fisheries management plan development to sustain the utilization of fishery resources. To follow up on this directive, the SEAFDEC Secretariat and FAO co-organized the “2nd Training Workshop on Stock Assessment in Support the Implementation of the International Commitments for Sustainable Use of Fisheries Resources in Southeast Asia” from 29 August to 6 September 2022 at SEAFDEC/TD in Samut Prakan, Thailand (onsite and online). Supported by fish stock assessment experts from the FAO and universities in the United States and Mexico, the training course was attended by fishery biologists from the SEAFDEC Member Countries, namely: Brunei Darussalam, Indonesia, Malaysia, Philippines, Thailand, and Viet Nam, who are responsible for the national stock assessment program in marine fisheries resources. The training course focused on stock assessment and analysis of the respective countries’ data using various models such as length-based stock production ratio (LBSPR), surplus production model, yield per recruit, productivity susceptibility analysis, data processing and verification, relationship between catch and CPUE, among others. During the training, the participants also learned how to interpret the results of the assessment and developed science-based management advice for management plans toward sustainable utilization of fishery resources.



2nd Training Workshop on Stock Assessment in Support of the Implementation of the International Commitments for Sustainable Use of Fisheries Resources in Southeast Asia on 29 August–6 September 2022

The COVID-19 pandemic is another emerging issue that continued to affect the life and economy of all countries and sectors including the fisheries of Southeast Asia. The activities of SEAFDEC to obtain information on the impacts and mitigation of the impacts of COVID-19 through the “Study on Impacts of COVID-19 Pandemic on the Fisheries Sector of the ASEAN-SEAFDEC Member Countries” was undertaken in 2021. To conclude the results of this study, the SEAFDEC Secretariat organized the “Regional Workshop for the Finalization of the Study Report on Impacts of COVID-19 Pandemic on the Fisheries Sector of the ASEAN-SEAFDEC Member Countries” on 20 April 2022 through an online platform. The Study report was submitted to SEAFDEC Council during its 54th Meeting in May 2022.



Regional Workshop for the Finalization of the Study Report on Impacts of COVID-19 Pandemic on the Fisheries Sector of the ASEAN-SEAFDEC Member Countries on 20 April 2022

Another important activity under this Project was the monitoring of the implementation of 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 Member Countries in 2020. SEAFDEC facilitated the development of the key indicators for monitoring and evaluation of the implementation of the Plan of Action 2030 through the conduct of two virtual regional workshops on 23–24 March 2022 and on 14 June 2022, respectively. In addition to the agreement on key indicators and monitoring template, the AMSs also agreed with the timeline for conducting the baseline monitoring (as of 2021), mid-term evaluation (2025), and final evaluation (2029). Subsequently, the AMSs were requested to provide the inputs for baseline monitoring, and it is planned that the final result from the baseline monitoring would be submitted to the SEAFDEC Council and the ASEAN mechanism in 2023.



RES&POA-2030: Regional Workshop on Development of the Key Indicators and Detailed Roadmap on 23–24 March 2022



RES&POA-2030: Regional Workshop on Finalization of the Key Indicators for Monitoring and Evaluation of the Implementation of the RES&POA-2030 on 14 June 2022

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 in 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.

Regional Capacity Building Network (RECAB)

The Regional Capacity Building Network (RECAB) was initiated by the SEAFDEC Secretariat and supported by the SEAFDEC Council during its 53rd Meeting in 2021 to be incorporated under the project “**Assistance for Capacity Development in the Region to Address International Fisheries-related Issues.**” By conducting technical training courses for relevant fisheries officers from the AMSs at the SEAFDEC Training Department, the RECAB is envisaged to strengthen regional cooperation and network among the AMSs on various subjects.

In 2022, the first RECAB activity was organized to commemorate the International Year of Artisanal Fisheries and Aquaculture (IYAFA) 2022. The SEAFDEC Secretariat with support from TD co-organized the “Regional Training Course on Gender Mainstreaming in Small-scale Fisheries and Aquaculture for Sustainable Development in Southeast Asia” on 20–29 September 2022 in Rayong Province and at SEAFDEC/TD in Samut Prakan Province, Thailand. There were 19 fisheries officers from the AMSs, namely: Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Thailand, and Viet Nam attended the activity together with resource persons and representatives from the SEAFDEC Secretariat, TD, AQD, MFRDMD, and IFRDMD. Aside from building up the regional fisheries network on gender, the participants gained knowledge of gender including concepts, roles, mainstreaming tools, and analysis framework. The participants also learned to identify actions to integrate gender into small-scale fisheries and aquaculture development projects. It is expected that the participants could apply the knowledge to their works with the ultimate goal of the well-being of small-scale fisheries and aquaculture in the Southeast Asian region.



“Regional Training Course on Gender Mainstreaming in Small-scale Fisheries and Aquaculture for Sustainable Development in Southeast Asia” as the first RECAB activity of SEAFDEC

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

In line with the implementation of the SSF Guidelines, FAO supported SEAFDEC/TD in the implementation of the project “**Gender Dimension in the Value Chain of Small-scale Fisheries and Aquaculture in Southeast Asia**” in order to improve and strengthen the gender dimension in selected small-scale fisheries and aquaculture value chain in Southeast Asia. The Project was comprised of 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 30 June 2022 since the activities could not be completed within the original timeline due to the COVID-2019 situation.

From 2020 to 2021, TD completed the activities in the pilot sites, namely: 1) Surat Thani Province in Thailand, 2) Bolikhamxay Province in Lao PDR, 3) Kyauktan, Yangon in Myanmar, and 4) Infanta, Quezon in the Philippines. In each of the sites, the activities started with the conduct of site training for enumerators on gender concept and analysis, followed by data collection and analysis, and data validation workshop.

In the year 2022, TD continued the implementation of the remaining activities in the pilot sites, *i.e.* the “Data Validation Workshop on Gender Dimension in the Value Chain of Small-scale Marine Fisheries” from 15 to 17 March 2022 in Quezon Province, Philippines. After the completion of all site activities, TD conducted the “Regional Workshop on Gender Dimension in the Value Chain of Small-scale Fisheries and Aquaculture in Southeast Asia” on 30 May 2022 via an online platform. At the Workshop, the results of the Project from the four countries were reported, including the “Training Modules” on gender mainstreaming in fisheries and information materials developed through the Project such as the infographics on the daily life of women and men in small-scale aquaculture and fisheries and video to promote gender in fisheries.



Regional Workshop on Gender Dimension in the Value Chain of Small-scale Fisheries and Aquaculture in Southeast Asia on 30 May 2022 via the online platform

5.3 Recognition of the importance of small-scale fisheries and aquaculture

Celebration of the International Year of Artisanal Fisheries and Aquaculture 2022

In September 2022, SEAFDEC took part in commemorating the “International Year of Artisanal Fisheries and Aquaculture (IYAFA) 2022” by launching the publication “Small-scale Fisheries of Southeast Asia: A Regional Digest.” This publication was prepared by the SEAFDEC Secretariat in collaboration with the Departments, Member Countries, and relevant international/regional agencies. The highlights in this publication were the key accomplishments of SEAFDEC projects and initiatives undertaken since the 1960s pertaining to small-scale fisheries and aquaculture in the Southeast Asian region.



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 survey

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 the conduct of fishery resource surveys to obtain 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.**”

In 2022 TD planned 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 SEAFDEC/TD and the Department of Fisheries, Thailand in the Gulf of Thailand, 2) marine environment and fishery resources survey by using a research vessel and evaluate the impacts of microplastics on the fisheries resources, and 3) marine fisheries resources, environmental and marine debris research survey in the Gulf of Thailand.

However, due to the revision of the budget proposal and the continued COVID-19 pandemic in 2022, only the cruise on “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” was carried out in six 6 service days. The aim of the cruise was the initial improvement of the benefit utilization of M.V. SEAFDEC 2 through standardization between the M.V. SEAFDEC and the government research vessel of Thailand in order that the data from SEAFDEC could contribute to the CPUE data in Thai waters in the future. Moreover, the cruise also contributed to the capacity building of seven researchers and 17 crew members of TD, and three staff from the DOF Thailand on methods for data collection from the cruise. As for the cruise “marine environment and fishery resources

survey by using a research vessel and evaluate the impacts of microplastics on the fisheries resources,” the cruise was postponed to 2023; while the cruise “marine fisheries resources, environmental and marine debris research survey in the Gulf of Thailand” was canceled.

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

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

The UNEP/GEF **Implementing the Strategic Action Programme for the South China Sea and Gulf of Thailand** (SCS SAP Project) aims to assist the countries in meeting the targets of the approved Strategic Action Program for the marine and coastal environment of the South China Sea through the implementation of the National Action Plans in support of the SAP and strengthening regional coordination for SCS SAP implementation. This will be achieved through three components, namely: 1) Reducing habitat degradation and loss via national and local reforms to achieve Strategic Action Programme targets for coastal habitat management in the South China Sea; 2) Strengthening knowledge-based action planning for the management of coastal habitats and land-based pollution to reduce environmental degradation of the South China Sea; and 3) Facilitating regional and national level integration and cooperation for implementation of the South China Sea Strategic Action Programme. The Project is executed by the United Nations Office for Project Services (UNOPS) and SEAFDEC together with the environment ministries of Cambodia, China, Indonesia, Philippines, Thailand, and Viet Nam.

In 2022, to facilitate the regional and national levels of integration and cooperation for the implementation of the SCS SAP Project, the “First Regional Scientific and Technical Committee Meeting” was organized from 17 to 19 October 2022 in Bangkok, Thailand. The Project also developed the regional database to revitalize regional mechanisms for communications, knowledge exchange, and information and data management and sharing. Moreover, the “First Regional Working Group on Land-based Pollution (RWG-LbP) Meeting of the SCS SAP Project” was organized on 13 December 2022 via an online platform. The objectives of this meeting were to 1) establish the regional working group on land-based pollution and its members, 2) review and present the SCS Project outputs and the SAP targets for land-based pollution, 3) present and discuss the status of SAP implementation achievement on land-based pollution from 2008–2021 including best practices, 4) share and present best practices on land-based pollution management, 5) review and discuss prioritization of land-based pollution activities for implementation, and 6) discuss the executing arrangement and workplans for 2022–2023.



First Regional Scientific and Technical Committee Meeting on 17 to 19 October 2022 in Bangkok, Thailand



First Regional Working Group on Land-based Pollution (RWG-LbP) Meeting of the SCS SAP Project on 13 December 2022 through the online platform

6.3 Enhancing human resources within the SEAFDEC organization

SEAFDEC Capacity Development through USAID Sustainable Fish Asia Activity

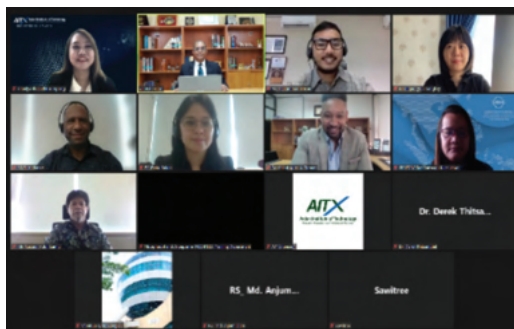
The “**Sustainable Fish Asia Project (SUFIA) Local Capacity Development (LCD) Activity**” is a two-year collaboration project funded by USAID with a duration from October 2020 to August 2022. To achieve the overall goal of the SUFIA Project to mitigate threats to biodiversity from unsustainable and IUU fishing in the Southeast Asia and Pacific regions, the SUFIA LCD Activity was aimed at strengthening SEAFDEC, particularly on its leadership and capacity as a key regional institution in the Southeast Asian region for improved fisheries development, strengthened regional collaboration, improved management of multistakeholder platforms, compliance, and enforcement, as well as increased involvement of the private sector in sustainable fisheries management and development. Carried out by the Research Triangle Institute (RTI) International in collaboration with the SEAFDEC Training Department, the LCD Activity was intended to assist SEAFDEC to meet the United States Government standards so that direct financing from the United States Government could be provided to SEAFDEC in the future. There are two main tasks of SUFIA LCD Activity, *i.e.*: Task 1 – organizational capacity assessment (OCA) and customized capacity development services for SEAFDEC; and Task 2: private sector landscape assessment to identify opportunities for collaboration with the private sector within the fisheries industry in the region.

Under **Task 1**, based on the organizational capacity needs and gaps identified through the assessment conducted in 2021, the Capacity Development Action Plan (C-DAP) was co-developed by the RTI International and SEAFDEC, and SEAFDEC was subsequently granted the “Capacity Strengthening Initiative (CSI) Subaward” from the RTI International to carry out activities starting from September 2021 until May 2022, focusing on improving administration and financial management and human resources management systems of the SEAFDEC/TD and the SEAFDEC Secretariat. As a result, a number of relevant institutional policy documents were updated or developed. Aside from upgrading the financial management software and compatible computer, SEAFDEC program managers and administrators enhanced their understanding of internationally accepted financial requirements, standard procedures for the management of sub-contracts, development of sub-partner agreements, and monitoring of performance through participating in several online training courses, *i.e.* Connect Learning with Monitoring and Evaluation (22–24 December 2021), Strategic Human Resources Management and Business Leadership

(December 2021–January 2022), USAID Rules and Regulations for Non-US Organizations: Grants and Cooperative Agreements (14–18 February 2022), Financial Management for USAID Fundings (2 February–9 March 2022), USAID Subaward Management (9 February–16 March 2022), and USAID Procurement: Grants and Cooperative Agreements (26 January–1 March 2022).



SEAFDEC/TD acquired nine units of new computers with upgraded financial and procurement software



SEAFDEC staff participated in online training on Strategic Human Resources Management and Business Leadership during December 2021–January 2022

On 7 April 2022, TD organized the “In-house Training on Three Administrative Policies and Concept of Human Resource Management” with the objectives to introduce to the staff the Guidelines for Preventing Conflicts of Interest, Code of Ethics and Anti-Fraud, and Anti-Corruption Policy and to provide the staff better understanding of the concept of human resource management and performance management, as well as the concept and importance of gender equality and social inclusion. Subsequently, SEAFDEC/TD organized on 12 May 2022 the “In-house Training on the USAID Funding Requirements” and on 17 May 2022 the “In-house Training on USAID Budget Preparation” to further share the information, knowledge, and key lessons learned from a series of training attended by other SEAFDEC staff.



Series of in-house training “Introduction of Three Administrative Policies and Concept of Human Resource Management,” “USAID Funding Requirements,” and “USAID Budget Preparation” in April and May 2022 at the SEAFDEC Training Department



Moreover, to follow up the “Co-creation Workshop” organized in November 2021 with the participation of staff from USAID and SEAFDEC, in early 2022 SEAFDEC continued to develop a Public International Organization (PIO) Grant Proposal which was submitted for a direct grant from the USAID to SEAFDEC. The project entitled “USAID/SEAFDEC/Sustainable Fish Asia-SEA Project”¹ was subsequently approved by the 45th Meeting of the SEAFDEC Program Committee at the end of 2022 as a new project under the FCG/ASSP mechanism from 2023 to 2027.

Task 2 focused on the development of private sector engagement activities based on Private Sector Landscape Assessment conducted in 2021. Through capacity building and consultation process, five concept notes were co-developed in 2021, 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). In 2022, the RTI team and TD staff continued to explore possible collaboration with the interested private sector. Eventually, under one of the concept notes “Support Infrastructure for an Ecosystem Approach to Fisheries Management,” some key infrastructures were provided by the private sector to Baan Nai Nang Fishing Cooperative, such as solar water pumps for two crab banks to help reduce operation cost for fishers, two computers to support recording of catch data and accounting. Overall, SEAFDEC enhanced the knowledge of its staff of private sector engagement and partnership through the training and webinars organized by RTI International.



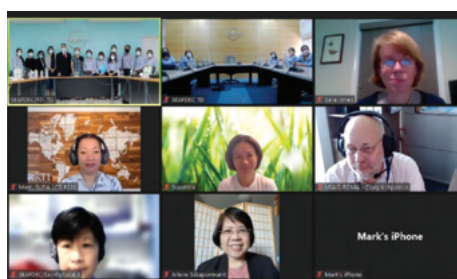
SUFIA/LCD staff facilitated meetings and trainings on private sector landscape assessment and partnership development from January to June 2022

In addition to activities under the aforementioned two Tasks, there were also a number of cross-cutting activities, including the development of communication and outreach products to disseminate lesson learned and success stories (e.g. reports, brochures, news), activities on gender inclusion/equality, and social inclusion, during the project implementation. A training session on “Program and Activity Result Reporting and Communication including Gender Sensitive Reporting” was arranged by RTI International for SEAFDEC staff on 19 April 2022 with the objectives to provide knowledge and skills to SEAFDEC staff on how to conduct program and activity result reporting and communication, demonstrate how to integrate GESI in reporting and communication materials, and document the training process and contents in a training report. It is expected that the Training would enable SEAFDEC to appropriately report and communicate the results of the projects to be funded by USAID in the future.

¹ Project title was subsequently changed to “USAID Southeast Asia Fisheries Partnership”

Achievements: Enhancing human resources within the SEAFDEC organization
Task1: Organizational capacity assessment (OCA) and customized capacity development services for SEAFDEC
<ul style="list-style-type: none"> Organizational Capacity Assessment (OCA) results with identification of strengths and weaknesses of SEAFDEC (focusing on TD and the Secretariat) Capacity Development Action Plan (C-DAP) that enhanced knowledge of staff through participation in training courses and facilitated TD to come up with: <ul style="list-style-type: none"> Financial Procedures and Policies Manual that comply with donor requirements, including Guidelines on Procurement of Products and Services, Inventory Management Manual, and Grant Administrative Manual Human Resources Management Policy, including Guidelines on Employee Recruitment and Selection, Code of Ethics and Code of Conduct, Anti-Fraud and Anti-Corruption Policy, and Guidelines for Preventing Conflicts of Interest Project management procedures, including Monitoring, Evaluation and Learning (MEL) Manual and timesheet management system Public International Organization (PIO) Grant Proposal developed and submitted to USAID
Task 2: Private sector landscape assessment to identify opportunities for collaboration with the private sectors within the fisheries industry in the region.
<ul style="list-style-type: none"> Private Sector Landscape Assessment (PSLA) results Five concept notes of activities to explore the opportunity to engage the private sector to invest in sustainable fishing practice Support from the private sector to one concept note on “Support Infrastructure for an Ecosystem Approach to Fisheries Management” e.g. computers, software, and solar cells for Baan Nai Nang fishing village
Cross-cutting activities
<ul style="list-style-type: none"> Enhanced the capacity for the development of communication products Enhanced the capacity for gender and social inclusion (GESI) considerations

At the end of the SUFIA/LCD Activity, the “Close-out Event” was organized on 18 July 2022 at SEAFDEC Training Department where the SUFIA/LCD activities and achievements over the past two years including lessons learned and program recommendations were presented. With the support of the USAID through the SUFIA/LCD Activity, SEAFDEC had strengthened both human and institutional capacities to support sustainable fisheries management plans and enhance public-private partnerships as well as enhanced compliance systems, and greater operational sustainability of the organization.



USAID Sustainable Fish Asia/Local Capacity Development (SUFIA LCD) Activity – Close-out Event on 18 July 2022 at SEAFDEC Training Department and online

SEAFDEC PROGRAMS FOR 2023

During the Forty-fifth Meeting of the SEAFDEC Program Committee on 5–7 December 2022 in Iloilo, Philippines, the programs and projects to be implemented by SEAFDEC in 2023 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 (17 ongoing and 5 new projects); 2) Departmental Programs (7 programs); and 3) Other Programs (2 programs). The list and description of programs and projects in 2023 appear as follows:

1) Project under the FCG/ASSP Mechanism

Ongoing Projects

Strategy and Project title	Lead Department	Funding Source
Strategy 1: Securing the sustainability of fisheries to contribute to food security, poverty alleviation and livelihood of people in the region		
<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, <i>i.e.</i> Database on Regional Fishing Vessels Record (RFVR) and 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 2023, the Project would continue to follow up, monitor, and facilitate the uploading by the AMSs of the key data elements to the RFVR database, and would organize for the AMSs the capacity building activity on MCS and regional workshop on subjects relevant to the international Law of the Seas. The Project would also continue to facilitate, trial, monitor, and transfer the eACDS application for Myanmar and support the implementation for Cambodia. Moreover, the Project would 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

Strategy and Project title	Lead Department	Funding Source
<p>2. Harmonization and Enhancing Utilization of Fishery Statistics and Information (2020–2024)</p> <p>The Project has the main 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. Moreover, based on the results from discussions at the RTCs organized in 2021 and 2022, SEAFDEC would organize in 2023 the 3rd RTC on Fishery Statistics and Information to discuss the remaining areas for improvement/incorporation in the revised Regional Framework on Fishery Statistics in Southeast Asia as well as the questionnaires to enhance the regional compilation of fishery statistics in the future. Meanwhile, the annual publication “Fish for the People” Volume 21 with three issues in 2023 would be also sustained under this Project.</p>	SEC	JTF
<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 fishery resources and the marine ecosystems with an emphasis on optimization of energy, improvement of fish handling and preservation techniques onboard, and promotion of responsible fishing technology through the training and studies. In 2023, the proposed activities include: 1) experiment on comparative efficiency and impacts of vee type and rectangular flat otter boards from a trawling experiment in the Gulf of Thailand by the M.V. PLALUNG; 2) sea trial for trawl monitor system (Scanmar) by the M.V. PLALUNG; 3) study on costs and revenues from fishing operations using the M.V. PLALUNG; 4) study on the sherbet ice system onboard for purse seine; 5) research on innovation and technology for optimizing energy, safety at sea, reducing labor onboard, and techniques to improve the quality of fish and onboard fish preservation; 6) regional training course for AMSs on optimizing energy use, safety at sea, and fish handling onboard; and 7) onsite training program on optimizing energy and onboard fish handling.</p>	TD	JTF

Strategy and Project title	Lead Department	Funding Source
<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 of 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 2023, MFRDMD would conduct two on-site training courses on taxonomy and biology at the selected landing sites in Yangon, Myanmar to enhance human resource capacity in elasmobranch taxonomy and biology as well as technique in data collection of sharks and rays up to species level. MFRDMD and TD would continue to support landing data collections in the participating countries. A training workshop on stock assessment models like the Bayesian Surplus Production model and Bayesian State Space Surplus Production Model is planned for the second quarter of 2023. This Project also continues the study on stock structures of one species of shark (<i>Carcharhinus sorrah</i>), one species of ray (<i>Maculabatis gerrardi</i>), and one CITES-listed species (<i>Sphyrna lewini</i>). With regard to the social survey on fishers' dependencies, marketing, and trade, the research framework is reconsidered by MFRDMD in collaboration with TD. Also, as a pilot activity, two series of nursery ground surveys of sharks and rays are ongoing in Nenasi, Pahang in collaboration with DoF Malaysia and other related organizations.</p>	MFRDMD	JTF
<p>5. 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</p>	TD	JTF

Strategy and Project title	Lead Department	Funding Source
<p>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 2023, the activities would focus on improving the knowledge of fisheries officers/researchers through the upcoming four training courses, namely: 1) regional training course on data collection for fisheries resources stock assessment; 2) regional training course on fish population dynamics and fisheries management using poor data condition model; 3) regional training course on GIS for marine resources management; and 4) regional training course on artificial reef design and site selection. In addition, the Project would also support researchers from the Member Countries to participate in the onboard surveys and prepare the cruise plan.</p>		
<p>6. 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 2023, MFRDMD would organize a workshop on stock and risk assessments of two neritic tuna species (<i>i.e. Thunnus tonggol</i> and <i>Euthynnus affinis</i>) to understand and share information on its stock status that could serve as the basis for considering fisheries management measures. In 2023, the Project would continue collecting and compiling the regional information on stock and risk assessment study for three pelagic species/groups (<i>i.e. Rastrelliger kanagartha</i>, <i>R. brachysoma</i>, <i>Decapterus</i> spp.) and two neritic tuna species (<i>i.e. T. tonggol</i> and <i>E. affinis</i>). Moreover, this Project would also continue the study on clarification of genetic structure of <i>E. affinis</i> and proceed with the analysis in collaboration with the Research Institute of Marine Fisheries (RIMF), Indonesia.</p>	MFRDMD	JTF

Strategy and Project title	Lead Department	Funding Source
<p>Considering that the data collection of <i>E. affinis</i> for clarification of genetic structure for the east coast of Peninsular Malaysia has already been completed in 2022, MFRDMD would begin the data collection of <i>E. affinis</i> in the west coast of Peninsular Malaysia. In 2023, MFRDMD would focus on the hard part (otolith) analysis to determine the age of <i>E. affinis</i> population on the east coast of Peninsular Malaysia. Once this process is completed, data validation and statistical analysis would commence.</p>		
<p>7. 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 that will be disseminated 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 publishing a manual for fish collecting/sampling information on biological characteristics. These activities would be conducted in Project sites in Lao PDR, Indonesia, and Viet Nam in 2023. Output 1 consists 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
<p>8. 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 2023, the Project activities in the following three components would be implemented: 1) Effective and appropriate use of fisheries management concept/approach/tools for small-scale fisheries in the Southeast Asian region,</p>	TD	JTF

Strategy and Project title	Lead Department	Funding Source
<p>2) Capacity development of the SSF team of TD and key officers of the Member Countries in the implementation of the FAO “Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication” for improving the livelihood and well-being of the small-scale fishers, and 3) Further promotion of the gender integration and empowerment in sustainable fisheries management in the Member Countries.</p>		
<p>9. 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. There are two main activities under the Project. The first one is on sustainable eel fisheries resources and standardization of data collection system in Southeast Asia. The second is on mapping the genetic population structure of tropical eels in Southeast Asia based on mtDNA approach. Although the COVID-19 pandemic affected the anguillid eel fishery in the Southeast Asia region, the collection of catch data and CPUE of anguillid eel fisheries in Indonesia (Cilacap, Palabuhan Ratu) and the Philippines (Cagayan and General Santos) are expected to continue in 2023. The Project activities would recommence in 2023 with survey and collection of catch and biological data. The genetic survey would also be continued to identify the genetic population structure of tropical anguillid eels in Southeast Asia using a D-LOOP region marker. The samples and tissues of <i>Anguilla marmorata</i> would be collected from the selected Member Countries (<i>i.e.</i> Indonesia, Philippines, Myanmar, and Viet Nam) and continued to be analyzed. 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 2023.</p>	IFRDMD	JTF

Strategy and Project title	Lead Department	Funding Source
<p>10. Development of Stock Assessment Methods and Strengthening of Resources Management Measures for Tropical Anguillid Eel in Southeast Asia (2020–2022, expected to extend to 2024)</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 the 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 2023, IFRDMD would continue the activities to establish the system for the collection of statistical data on catch and aquaculture of tropical anguillid eels, and conduct 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	JAIF
<p>11. Regional Collaborative Research and Capacity Building for Monitoring and Reduction of Marine Debris from Fisheries in Southeast Asia (2022–2023)</p> <p>The Project is aimed toward establishing regional collaborative research and capacity building in the fisheries sector, including the application of scientific knowledge in regional policies and monitoring based on four priority areas of the “ASEAN Framework of Action on Marine Debris” for combating marine debris in Southeast Asia. In 2023, the following activities will be carried out: 1) information gathering to estimate the amount of ALDFG and monitoring on the ALDFG at accumulated pilot sites and development of removal guidance of the ALDFG; 2) workshop for information exchange and the development of technical guidance on ALDFG countermeasures; 3) marine environment and fishery resources survey by using a research vessel, and evaluate the impacts of microplastics on the fisheries resources;</p>	TD	JAIF

Strategy and Project title	Lead Department	Funding Source
<p>4) research and evaluation on amount of marine debris collected by different types of fishing gears during the fishing activities at sea; 5) investigation and risk assessment of microplastics in freshwater fish and marine fish, and dissemination of the results on contaminant of microplastics; 6) on-the-job training on reliable research methods on marine debris and microplastics to officers and researchers in AMSs; 7) development of Project website and communication materials; and 8) producing the technical manual for marking of fishing gears</p>		
<p>12. ASEAN-JICA Cooperation for Capacity Building on IUU Fishing Countermeasures in Southeast Asia (2023–2026)</p> <p>Scheduled to commence in 2022, this Project was postponed to 2023. The 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 2023, TD would organize training courses on responsible fishing technologies/practices to combat IUU fishing in Southeast Asia. TD would also organize capacity building for the effective and efficient implementation of international instruments and tools to combat IUU fishing such as preventing the use of transshipment that supports IUU fishing and IUU fishery products from entering into the seafood supply chain in Southeast Asia. Moreover, a regional capacity-building workshop on enhancing policies and countermeasures against IUU fishing in Southeast Asia and a training course for fisheries inspectors in the implementation of Port State Measures (PSM) would be conducted.</p>	TD	JICA
<p>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</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. The activities to be undertaken in 2023 are as follows:</p>	AQD	JTF

Strategy and Project title	Lead Department	Funding Source
<ul style="list-style-type: none"> • Training on broodstock management and grow-out culture to achieve sustainable aquaculture of giant freshwater prawn (GFP) in the Laguna Lake and its tributaries, as well as in ponds near the lake • Feeding trials on the efficacy of insect meal and insect by-products on the productivity performance of GFP in biofloc and clear water conditions • Investigation on the efficiency of mitigating the disease effect the designed artificial/constructed wetland in a recirculating aquaculture system. • Optimization protocol for broodstock management and conduct of trials for larval rearing using the fertilized eggs or hatched larvae acquired from the brood stock. • Monitoring and surveillance of mass mortalities in aquaculture farms to isolate and identify the causative agent(s) of unknown and emerging crustacean and fish diseases, and development of disease diagnostic protocol(s) • Continuation of surveillance to determine the prevalence and emergence pattern of EHP in the Philippines, with cohabitation experiment to clarify the transmission mechanism of EHP • Laboratory examination of chemicals and methods that can be used to prevent the horizontal and vertical transmission of pathogens, especially WSSV • Experiments on integrated disease management of the shrimp under pond conditions during the wet and dry seasons • Two training courses “Marine Fish Hatchery” and “Community-Based Freshwater Aquaculture for Remote Rural Areas of Southeast Asia” • Distance Learning Course on Principles of Aquaculture Nutrition • Distance Learning Course on Principles of Health Management in Aquaculture • JTF annual and semi-annual meetings to review and evaluate the Project achievements 		

Strategy and Project title	Lead Department	Funding Source
Strategy III: Ensuring the food safety and quality of fish and fishery products for the Southeast Asian region		
<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 technical experts of the region. The Project comprises two scopes including 1) development of regional standards and guidelines on Good Manufacturing and Handling Practices (GMP&GHP) for Ready-to-Eat (RTE) raw fish and fishery products, and 2) introduction of High-Pressure Processing (HPP). Under the first scope, the AMSs will continue to conduct their respective GMP and GHP pilot trials until the second quarter 2023, after which there would be a mid-term review meeting and the preparation of Regional Guidelines on GMP and GHP. For the second scope, it is expected that the training materials and Handbook of HPP on fish and fishery products would be developed, and the regional training course on HPP technology would be organized.</p>	MFRD	JTF
<p>15. ASEAN-JICA Food Value Chain Development Project (2023–2026)</p> <p>This Project was scheduled to commence in 2022 but was postponed to 2023. The 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 activities to be implemented by SEAFDEC are under the third thematic area to support the fisheries sector in achieving the expected outputs, <i>i.e.</i> Food safety on fishery sector is improved by promotion of GAqP and development of ASEAN guidelines and relevant principles on fisheries inspection mechanism. However, as of the end of 2022, the planned sub-activities and its budget allocations have not yet been finalized and confirmed.</p>	SEC in collaboration with TD, AQD, and MFRD	JICA
Strategy IV: Enhancing trade and compliance of the region’s fish and fishery products with market requirements		
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Strategy and Project title	Lead Department	Funding Source
Strategy V: Addressing cross-cutting issues, such as labor, gender and climate change, where related to international fisheries		
<p>16. 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 2023, SEAFDEC would continue to support SEAFDEC staff to participate in the relevant regional/international fora <i>e.g.</i> those organized by the ASEAN, FAO, CITES, etc., and will update the status of the international fish trade-related issues by providing platforms for Regional Technical Consultation (RTC) for the AMSs to discuss international fish trade-related issues which may impact the development of fisheries and aquaculture in the Southeast Asian region. In addition, under the Regional Capacity Building Network (RECAB Network) program which was endorsed by the SEAFDEC Council during its 53rd Meeting in 2021, the SEAFDEC Secretariat in 2023 would collaborate with AQD to host the Regional Training Course on Integrated Trophic Aquaculture.</p>	SEC	JTF
Strategy VI: Empowering SEAFDEC to strengthen its roles in the region and to improve its services to Member Countries		
<p>17. Fisheries Resource Survey & 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 their respective fishery resources and marine environmental conditions and enhancing human resource development. As in 2022, SEAFDEC collaborated with the Member Countries <i>i.e.</i> Myanmar, Philippines, and Thailand in developing their respective cruise plan in 2023, SEAFDEC would follow up with the aforementioned Member Countries to finalize the cruise survey activities.</p>	TD	JTF, with cost sharing from AMSs requesting to use the vessel

Strategy and Project title	Lead Department	Funding Source
<p>Moreover, under the SEAFDEC-JAIF project “Regional Collaborative Research and Capacity Building for Monitoring and Reduction of Marine Debris from Fisheries in Southeast Asia,” the shipboard survey “Marine Environment and Fishery Resources Survey by Using a Research Vessel and Evaluate the Impacts of Microplastics on the Fisheries Resources” would be conducted during the third or fourth quarter of 2023 with expected 31 service days.</p>		

New Projects

Strategy/Project Title	Lead Department	Funding Source
<p>Strategy 1: Securing the sustainability of fisheries to contribute to food security, poverty alleviation and livelihood of people in the region:</p>		
<p>1. USAID/SEAFDEC/Sustainable Fish Asia-SEA Project¹ (2023–2027)</p> <p>The Project comprises four thematic areas, namely: 1) Data-driven Fisheries Management for Climate Change Mitigation and Adaptation; 2) Exploration of Seaweed Culture as Part of Blue Economy and Climate Change Mitigation; 3) Reducing Negative Impacts from Fishing on the Marine Ecosystem; and 4) Sustainable Inland Fisheries Management. The geographical areas cover the Southeast Asia region and will benefit the AMSs. The Project activities will work through regional and sub-regional approaches to be implemented in the first quarter of 2023 with the recruitment of a Project Manager, Monitoring, Evaluation and Learning Specialist, Communication Specialist, two Project Assistants (administrative/finance), and direct home office labors including procurement of project equipment. In 2023, the Project inception workshop will be organized as well as an expert consultation on tuna stock assessment and model development for the Sulu-Sulawesi Sea (SSS) sub-region. The Sulu-Sulawesi Sea project national inception workshops will be organized in Indonesia, Malaysia, and Philippines. In addition, expert consultation on inland fisheries management using ecosystem approach to fisheries and on-site visit to U.S. Marine Mammal Protection Act (MMPA) would be also conducted in 2023.</p>	<p>TD, in collaboration with MFRDMD, AQD, and IFRDMD</p>	<p>USAID</p>

¹ Project title was subsequently changed to “USAID Southeast Asia Fisheries Partnership”

Strategy/Project Title	Lead Department	Funding Source
<p>2. Sustainable Management of Fisheries, Marine Living Resources and Their Habitats in the Bay of Bengal Region for the Benefit of Coastal States and Communities (BOBLME Phase II) (2023–2026)</p> <p>The Project objective is to contribute to sustainable management of fisheries, marine living resources and their habitats in the Bay of Bengal region to reduce environmental stress and improve environmental status for the benefit of coastal states and communities. This will be achieved through five interlinked Project components based on the Strategic Action Programme (SAP) themes, namely: 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. SEAFDEC will be the Executing Agency to be responsible for the Project implementation in participating countries that are SEAFDEC Member Countries, namely: Indonesia, Malaysia, and Thailand; while the implementation in non-SEAFDEC members, <i>i.e.</i> Bangladesh, India, Maldives, and Sri Lanka would be under the responsibility of the BOBP-IGO. The Project was endorsed by the GEF CEO in March 2022, and the Operational Partners Agreement (OPA) between SEAFDEC and FAO is expected to be signed in early 2023. The detailed Project plan of activities will be agreed upon when the Project enters into its Inception Phase.</p>	TD	FAO/GEF and Norad
<p>3. Promoting the Blue Economy and Strengthening Fisheries Governance of the Gulf of Thailand through the Ecosystem Approach to Fisheries (GoTFish Project) (2023–2027)</p> <p>The aim of the Project is “Improved natural resource governance in the GoT through the implementation of the ecosystem approach to fisheries (EAF) contributing to the broader, regional fisheries objectives of the South China Sea Strategic Action Programme (SCS-SAP).” To achieve this, the GoTFish Project will work on four main components: 1) Regional transboundary fisheries governance and management strengthened; 2) Alignment of incentive mechanisms;</p>	TD	FAO/GEF

Strategy/Project Title	Lead Department	Funding Source
<p>3) Ecological Corridor of Critical and Important Habitat for Aquatic Resources in the Gulf of Thailand (with focus on Malaysia); and 4) Stakeholder engagement, communication, monitoring and evaluation. SEAFDEC will be the Executing Agency to be responsible for Project Component 1 and Component 4. There are four Project participating countries, namely: Cambodia, Malaysia, Thailand, and Viet Nam. The full Project document was submitted to GEF in 2022, and it is expected that the Project will commence in 2023 upon GEF approval. The detailed Project plan of activities and indicative budget plan for 2023 will be confirmed again once the Project Document is endorsed.</p>		
<p>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</p>		
<p>4. Blue Horizon: Ocean Relief through Seaweed Aquaculture (2023–2026)</p> <p>The overarching goal of the Project “Blue Horizon: Ocean Relief through Seaweed Aquaculture” is to create new sustainable seaweed value chains that will deliver ecosystem services and provide socioeconomic benefits to communities, particularly to households whose livelihoods depend on marine ecosystems. To achieve the goal, the Project will be implemented through its four components, namely: 1) Regional capacity building for seaweed aquaculture; 2) Enabling environment for seaweed aquaculture in Philippines and Viet Nam; 3) Seaweed value chains (production + processing + marketing); and 4) Knowledge Management, M&E, and IW Learn (regional). The Project participating countries are Philippines and Viet Nam. The GEF CEO endorsed the Project document in July 2022, and the Project is now in the process of preparation for commencement. The detailed plan of activities will be agreed upon when the Project enters into its Inception Phase.</p>	<p>SEC in collaboration with AQD</p>	<p>WWF-US/ GEF</p>

Strategy/Project Title	Lead Department	Funding Source
<p data-bbox="236 268 848 330">5. Regional Technical Consultation on Aquatic Animal Health Emergencies in Southeast Asia (2023)</p> <p data-bbox="236 362 848 1104">The proposed “Regional Technical Consultation (RTC) on Aquatic Animal Health Emergencies in Southeast Asia” will bring together again the same representatives attending the “RTC on AEPRS for Effective Management of Transboundary Disease Outbreaks in Southeast Asia” organized in 2018 with the added participation of people from the private sector and the academe to assess the status of the respective AMSs contingency plans regarding disease control. The RTC would be the avenue to identify the gaps in the contingency plan(s) of each AMS. This RTC is intended to facilitate the further development and refinement of a regional aquatic emergency preparedness and response system that will result in the more systematic management of aquatic animal disease outbreaks in the region; while also strengthen the cooperation among the AMSs, regional/international organizations, the academe, fish farmers, and other relevant stakeholders on initiatives that support emergency preparedness and response systems for effective management of aquatic animal disease outbreaks. Currently, AQD is coordinating with the Japan-ASEAN Integration Fund Management Team (JMT) to submit the proposal in the first quarter of 2023 so that the RTC could be conducted in 2023.</p>	AQD	JAIF

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 stock enhancement. In 2023, the Program would continue to undertake the following research until the conclusion:</p> <ul style="list-style-type: none"> • Nursery and grow-out culture of snubnose pompano <i>Trachinotus blochii</i> in pond-based net cages • Use of biofloc system on mangrove crab larval rearing and indoor nursery culture • Nursery culture of mangrove crab <i>Scylla serrata</i> megalopae in pond-based net cages • Verification of adequate feeding rations and use of algal paste for single seed spat production of slipper-shaped oyster <i>Crassostrea iredalei</i> • Optimizing the survival of micropropagated seaweed <i>Kappaphycus alvarezii</i> through acclimation in tank-based nursery systems • Sea-based nursery cage production of farmed eucheumatoids • Hatchery production of early juvenile sandfish <i>Holothuria scabra</i> • Mass production of mud polychaete <i>Marphysa iloiloensis</i> in indoor tanks • Development of a modified continuous culture system for the mass production of <i>Nanochlorum</i> sp. and <i>Brachionus rotundiformis</i> • Use of microalgal paste-fed <i>Proales similis</i> in marine fish larviculture: I. Refinement of <i>P. similis</i> mass production schemes and II. Assessment of <i>P. similis</i> as the first food for marine fish larvae • Development of a protocol for large-scale culture of harpacticoid copepods for marine fish larviculture • Mass production of all-male and mixed sex tilapia fingerlings and promotion of saline tolerant tilapia • Seed production of donkey's ear abalone <i>Haliotis asinina</i> juveniles • Mass production of mangrove crab (<i>Scylla serrata</i>) seedstock • Seed production of freshwater prawn <i>Macrobrachium rosenbergii</i> • Production of farmed eucheumatoids by micropropagation in the land-based nursery 	AQD	AQD*

Program Title	Department	Funding Source
<p>2. Healthy and Wholesome Aquaculture (<i>ongoing</i>)</p> <p>The Program has two main components, namely: 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 2023 would include:</p> <ul style="list-style-type: none"> • Field verification of the vaccination regimen in cage-cultured marine fish species (pompano, snapper, grouper) broodfish in AQD Igang Marine Station as a practical strategy to prevent the vertical transmission of nervous necrosis virus during seed production • 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> • Verification of probiotic supplementation in enhancing growth, survival, and immune response of juvenile abalone <i>Haliotis asinina</i> • Epidemiology of skin ulceration disease (SKUD) in juvenile and adult sea cucumber (<i>Holothuria scabra</i>) • Treatment regimen on tissue culture seaweed plantlets affected by disease and epiphytic pest using commercially available chemicals • Identification and treatment of risk factors affecting diseases of different aquaculture species <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. In 2023, the following studies will continue:</p> <ul style="list-style-type: none"> • Culture of pompano <i>Trachinotus blochii</i> in floating net cages • Production techniques for culture of silver therapon (<i>Leiopotherapon plumbeus</i>) in tanks and cages • Efficiency and profitability of Nile tilapia (<i>Oreochromis niloticus</i>) and giant freshwater prawn (<i>Macrobrachium rosenbergii</i>) polyculture in pond-based biofloc system 	AQD	AQD*

Program Title	Department	Funding Source
<ul style="list-style-type: none"> • Efficiency of polychaete phospholipid in promoting <i>Penaeus monodon</i> maturation • Refinement of <i>Scylla serrata</i> maturation diet • Verification of the refined grow-out formulation for <i>S. serrata</i> 		
<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 2023, most of the studies undertaken in 2022 would be continued including:</p> <ul style="list-style-type: none"> • Community-based production of sea cucumber • Co-culture of tilapia and giant freshwater prawn in tanks and lake-based cages • Mixed diet for abalone grow-out culture • Managing tropical anguillid eel resources for sustainable use • Assess and develop an intermediate culture system for tropical aquaculture species • Improved production of abalone and sandfish 	AQD	AQD*
<p>4. Meeting Socio-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 2023, two studies undertaken in 2022 would be continued.</p> <p>For the study conducted in Barangay Molocaboc in Sagay, Negros Occidental, Philippines, the plans for 2023 include:</p> <ul style="list-style-type: none"> • Implementation of family-based managed floating hapa nursery • In-person presentation of educational video material to Molocaboc primary and secondary students • Exploration of sandfish market product/s and market linkages 	AQD	AQD*

Program Title	Department	Funding Source
<p>For the study conducted in Barangay Pipindan in Binangonan, Rizal, Philippines aims to achieve the following in 2023:</p> <ul style="list-style-type: none"> • Sustained production and selling of post larvae to generate income for fishers organization, operations, and supplemental income for participating members • Enhanced training in broodstock management • Sustained community-based hatchery operations and family-based grow-out culture • Explore trial ranching opportunities in the Laguna Lake and tributaries 		
<p>5. 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 2023, 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"> • Fry Sufficiency Program • Development of cost-efficient feeds • Oplan Balik Sugpo (Operation Black Tiger Shrimp Revival) • In-situ (onsite) training courses and accelerated technology transfer • Manpower Development 	AQD	AQD*
<p>6. 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 2023, the following activities under three categories would be continued.</p> <p>1) Promotion of appropriate technologies and practices of fishing and marine engineering</p> <ul style="list-style-type: none"> • Finalization of the Handbook of the Scientific Echo Sounder EK 80 	TD	TD*

Program Title	Department	Funding Source
<ul style="list-style-type: none"> Development of reference documents for the Inland Fisheries Training Course for the Department of Fisheries, Thailand 2) Study on the impacts on fisheries resources, marine environmental, social well-being, and livelihood from fishing activities <ul style="list-style-type: none"> Study the type and amount of debris in the surface layer of the Chao Phraya River that flows into the Gulf of Thailand Preliminary study on the End of Life Fishing Gear (EOLFG) in Thailand 3) Database for fisheries management <ul style="list-style-type: none"> Development and trial use of database system of small-scale fisheries with the a pilot case of Krabi Province 		
7. Promotion on Strengthening of SEAFDEC Visibility and Enhancing Human Capacity Building (<i>ongoing</i>) 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 2023, the activities would be categorized into 1) Promotion and enhancement of SEAFDEC visibility and image; 2) Production of information materials, e.g. books, brochures, videos, and other media, to raise 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.	TD	TD*

* Funding from regular contributions of respective Host Governments

3) Other Programs

Program Title	Department	Funding Source
1. Implementing the Strategic Action Programme for the South China Sea (SCS SAP) (2018–2023) Executed by the United Nations Office for Project Services (UNOPS) and SEAFDEC in six participating countries, namely: Cambodia, China, Indonesia, Philippines, Thailand, and Viet Nam, the Project has the objective of	TD	UNEP/GEF

Program Title	Department	Funding Source
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 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.		
2. Seminar-Workshop on Aquaculture Development in Southeast Asia (ADSEA) (2023) The Seminar-Workshop on Aquaculture Development in Southeast Asia (ADSEA) was proposed to be conducted by AQD in 2021 but was postponed to 2022 and again to 2023. The objectives of the ADSEA are 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*, JTF

* Funding from regular contributions of respective Host Governments

In addition to the above projects and programs, there was also one **pipeline project** of which the proposal is being prepared in consultation with the respective donor agency and SEAFDEC Member Countries.

Project Title	Department	Funding Source
1. Implementation and Assessment of the ASEAN Regional Plan of Action for the Management of Fishing Capacity *	MFRDMD	JAIF

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

COOPERATION WITH DONORS AND OTHER ORGANIZATIONS IN 2022

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 2022, 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 2022, nineteen (19) projects were implemented by SEAFDEC under the FCG/ASSP Mechanism. The progress and achievements of these projects were reported to the Twenty-fifth Meeting of the FCG/ASSP organized during 8–9 December 2022 in Iloilo City, Philippines.

In 2022, SEAFDEC was also represented in a number of events organized by the ASEAN, namely:

- 12th Meeting of ASEAN Shrimp Alliance (ASA) (20 June 2022, online)
- 14th Meeting of the ASEAN Fisheries Consultative Forum (AFCF) (21 June 2022, online)
- 30th Meeting of the ASEAN Sectoral Working Group on Fisheries (ASWGF) (22–23 June 2022, online)

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

SEAFDEC is collaborating with the Food and Agriculture Organization of the United Nations (FAO) in the implementation of a number of fisheries projects in Southeast Asia.

For the project “Gender Dimension in the Value Chain of Small-scale Fisheries and Aquaculture in Southeast Asia,” the Letter of Agreement (LOA) was originally signed in early 2020 with the duration from 1 January 2020 to 30 June 2021, with an extension until 30 June 2022. From January 2020 to June 2022, the Project was implemented in the participating countries, namely: Lao PDR, Myanmar, Philippines, and Thailand with the aim of enhancing the capacity of the participating countries’ staff involved in fisheries management and development programs and projects to enable them to integrate gender aspects in their respective program/project cycles. The Project was successfully concluded in 2022 with the conduct of the “Regional Workshop on Gender Dimension in the Value Chain of Small-scale Fisheries and Aquaculture in Southeast Asia” on 30 May 2022 to present the results and outputs of the Project.

With regard to the project on “Survey to Estimate Levels of Abandoned, Lost or otherwise Discarded Fishing Gear in Thailand Gillnet and Trap Fisheries,” the LOA was originally signed

in early 2020 with the duration from 2 April 2021 to 30 November 2021, with an extension until 30 January 2022. The Project was implemented in Thailand to conduct 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) as well as develop a database to compile the data from the surveys in coastal provinces of Thailand as an example to estimate the levels of ALDFG. The Report on the Investigation to Estimate the Abandon, Lost, and Discard Gillnet and Traps (pots) along the Coast of Thailand (Phang Nga and Krabi Provinces) was submitted to FAO in February 2022.

Another project was “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,” and its LOA was signed on 9 December 2021 with an amendment on 17 June 2022 to cancel the activity on Terminology proposed by Aquatic Genetic Resources. The activities implemented by SEAFDEC under the revised LOA included: 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; and 3) Research and data recorded by participants will undergo bibliometric analysis with results presented in a report. After the development of search strategies to ensure that most of the research and datasets produced from the target countries will be covered, five training sessions were conducted in July–August 2022 with a total of 15 participants from Cambodia (2), Indonesia (6), Philippines (3), and Viet Nam (4). The participants were trained in creating records for different types of resources (including datasets) in OpenASFA Solutions. The results generated by the participants were combined with the 350 records that had been exported from the ASFA database, to give a total of 1,397 records, which comprised 447 books, 702 journal articles, 109 chapters, and 139 data sets.

In 2022, SEAFDEC was also involved in regional and international events organized by FAO with the view of ensuring that the activities and initiatives promoted by SEAFDEC are harmonized with relevant international instruments and initiatives. These include:

- 36th Session of the FAO Regional Conference for Asia and the Pacific (APRC) (8–10 March 2022, online)
- Regional Validation Workshop for the Promoting the Blue Economy and Strengthening Fisheries Governance of the Gulf of Thailand through the Ecosystem Approach to Fisheries (GoTFish Project) (16–17 March 2022, online)
- Intersessional Meetings of Aquaculture and Fisheries Subject Group (20–23 June 2022, online)
- 27th Coordinating Working Party on Fishery Statistics (24 June 2022, online)
- 18th Session of the Sub-Committee on Fish Trade of the Committee on Fisheries (7–9 and 20 June 2002, online)
- Technical Consultation on Voluntary Guidelines for Transshipment (30 May–3 June 2022, Rome, Italy)
- Workshop on Fisheries Data Collection and Statistics for Asia and Pacific (26–27 July 2022, online)
- 9th Meeting of the Regional Fishery Body Secretariats’ Network (2–3 and 9 September 2022)

- 35th Session of FAO Committee on Fisheries (5–9 September 2022, Rome, Italy)
- Workshop on Fisheries Data Collection and Statistics (Global) (8–9 November 2022, online)

In 2022, FAO also extended the expertise of its resource persons in several events organized by SEAFDEC, including, among others the expertise of:

- *Ms. Stefania Vannuccini* during the 2nd Regional Technical Consultation on Fishery Statistics and Information in Southeast Asia (organized by SEAFDEC Secretariat on 23–26 August 2022 in Pattaya, Chonburi Province, Thailand)
- *Dr. Kim Friedman* during the Regional Technical Consultation on the Development of the ASEAN-SEAFDEC Common Positions on the Proposed Listing of Commercially-exploited Aquatic Species into the CITES Appendices (organized by SEAFDEC Secretariat on 30 August–1 September 2022, Bangkok, Thailand)
- *Dr. Rishi Sharma* during the 2nd Training Workshop on Stock Assessment in Support the Implementation of the International Commitments for Sustainable Use of Fisheries Resources in Southeast Asia (co-organized by SEAFDEC Secretariat and FAO on 29 August to 6 September 2022 onsite at SEAFDEC/TD in Samut Prakan, Thailand and online)
- *Ms. Jennifer Gee* during the Regional Training Course on Gender Mainstreaming in Small-scale Fisheries and Aquaculture for Sustainable Development in Southeast Asia (organized by SEAFDEC Secretariat and SEAFDEC/Training Department on 20–29 September 2022)

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

In 2022, the United States Agency for International Development Regional Development Mission for Asia (USAID/RDMA) continued to implement the two-year project “Sustainable Fish Asia (SUFIA)” which was launched in 2021 and 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). The Project comprises 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. As part of the SUFIA Project, SEAFDEC received a sub-award from RTI for the “Local Capacity Development” (LCD) with the purpose to implement activities to enhance the capacities of SEAFDEC for compliance with USAID’s requirements as a public international organization (PIO). Implemented from 2021 to 2022, this sub-awarded activity was concluded with the “Close Out Event” on 18 July 2022 at the SEAFDEC/TD to present the SUFIA/LCD activity achievements over the past two years, not only to improve the organizational capacities in administrative, financial, and human resources aspects in compliance with international standards including the requirements of the USAID, but also in developing a new regional program through the PIO Grant of the USAID.

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

(NOAA) during the Regional Training Course on Port State Measures Inspection in Focus of Shipping Container for Fish and Fisheries Products (13–15 September 2022, Samut Prakan, Thailand), namely:

- *Ms. Siri Hakala*, Foreign Affairs Specialist
- *Mr. Elliott Matthews*, International Fisheries Fellow
- *Mr. Charlie Nguyen*, Enforcement Officer
- *Mr. Jeremy Munkelt*, Special Agent
- *Mr. Radford Dew*, Assistant Special Agent in Charge
- *Mr. Richard Chesler*, Assistant Special Agent in Charge

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

In 2022, 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. The 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.

From 2018 to 2022, the Project accomplished the construction of fish passes in Cambodia at Stung Phasat Watershed, Srei Snom, Romlech 1, and Romlech 2, Thailand at Hany Wang Chang Weir in Udon Thani Province, and Viet Nam at Ea Tul weir Dac Lac Province. The Project was completed with the conduct of a close-out event on 18 October 2022 at TD by inviting representatives from the participating countries related to Implementing the Lower Mekong Fish Passage Initiative to present the achievements.

2. Cooperation with National Agencies of SEAFDEC Member Countries

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

SEAFDEC is collaborating with Japan Fisheries Research and Education Agency (FRA) through the “Arrangement for Scientific and Educational Cooperation between Japan Fisheries Research and Education Agency (FRA) and SEAFDEC” which was signed on 22 January 2019 with the objectives of 1) developing scientific and technical cooperation in various fields that are of interest to the two relevant organizations under the mutual understanding and interrelationship, and 2) developing academic and educational cooperation in various fields that are of interest to the two relevant organizations under the mutual understanding and interrelationship. Under this cooperative framework, TD welcomed the President of FRA, *Dr. Ichiro Nakayama*, and his colleagues on 13 September 2022. During their visit, the staff of TD introduced the roles and activities of SEAFDEC in the region. Moreover, the visitors

observed TD facilities such as the fishing workshop, marine engineering workshop, and M.V. SEAFDEC. A discussion was made on the area of cooperation between SEAFDEC and FRA in the future.

Specifically, under the cooperative arrangement, a number of experts were dispatched to the SEAFDEC Departments in 2022, namely:

- *Dr. Sayaka Ito* as Deputy Chief of AQD
- *Dr. Masaya Katoh* as Deputy Chief of MFRDMD (*until 31 March 2022*)
- *Dr. Masahito Hirota* as Deputy Chief of MFRDMD (*since 1 April 2022*)
- *Dr. Toshiya Suzuki* as Deputy Chief of IFRDMD (*until 31 March 2022*)
- *Mr. Tomohito Shimizu* as Deputy Chief of IFRDMD (*since 1 April 2022*)

- **Japan International Research Center for Agricultural Sciences (JIRCAS)**

On 29 March 2022, AQD signed a Memorandum of Agreement between AQD and Japan International Research Center for Agricultural Sciences (JIRCAS). Under the MOA, AQD and JIRCAS shall mutually plan and implement research projects in accordance with their intended cooperation; and facilitate the exchange of scientists through related research projects, seminars, trainings, and site visits. Research collaboration project under this MOA is under the theme “Development of an aquaculture system that introduces high-valued seedling production and intermediate culture in harmony with environment in tropical areas,” with three sub-studies, namely: 1) assessment and development of an intermediate culture system for tropical aquaculture species, 2) development of surrogation technique and genetic resource conservation system by transplantation and cryopreservation of germ cells in fish, and 3) improvement of larval settlement and post-larval production for abalone *Haliotis asinina* and sandfish *Holothuria scabra*. Subject to personnel and budgetary limitations and as may be mutually decided upon, JIRCAS shall provide Visiting Scientists to work on the research projects that are in line with the mandate of AQD and that of JIRCAS, together with salaries and miscellaneous expenditures for the visiting scientists, equipment required for research projects, and financial support to general workers mobilized for the projects; while AQD shall provide office, laboratory space, and access to field research sites for the project, administrative mechanisms for the research projects, counterpart scientists for JIRCAS visiting scientists, as well as other necessary arrangements and clearance for the JIRCAS visiting scientists. The MOA is effective from the signing date until 31 March 2026.

- **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.

- **PTT Exploration and Production (PTTEP) Public Company Limited**

SEAFDEC together with the PTT Exploration and Production (PTTEP) Public Company Limited, Department of Fisheries (DOF) of Thailand, Faculty of Fisheries of Kasetsart University, and Prince of Songkla University signed the Memorandum of Agreement (MOA) on 19 December 2022 in Bangkok, Thailand for the implementation of the project on the rehabilitation of fisheries habitats in the oil rig platform in the Gulf of Thailand. The objectives of the project are to enhance fishing activities by developing and restoring aquatic habitats, fishery resources, and marine ecosystems as well as promote aquatic resource management in accordance with the concept of sustainable and balanced marine ecosystems. The MOA is effective from 19 December 2022 to 18 December 2025.

PROGRESS IN THE IMPLEMENTATION OF INFORMATION STRATEGIES FOR ENHANCING SEAFDEC VISIBILITY AND COMMUNICATION IN 2022

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

In 2022, the progress and achievements made by SEAFDEC in the implementation of the Information Strategies were monitored and discussed during the 23rd Meeting of the Information Staff Program (ISP) from 18 to 20 October 2022 in Bali, Indonesia, and were subsequently updated to cover the period from 1 January to 31 December 2022. 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: 34 title/issues produced: 4,482 copies published, with 3,299 hard copies and 13,708 e-copies distributed
- Technical videos: 39 titles produced, with 5,605 online views
- Technical/scientific articles: 63 titles produced, with 25 titles published in SEAFDEC publications and 38 titles published in non-SEAFDEC publications
- Inquiries for information through the SEAFDEC libraries recorded and replied: 4,254 queries recorded (including 232 from e-mail, 1,085 from social media, 473 from website, 2,154 from repository, and 310 from library), and 661 materials sold
- Number of citations: 27,258 citations (including 26,198 citations from Scopus, and 1,060 citations from Google Scholar)

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

- Promotional materials: 38 titles/issues produced: 18,821 copies published, with 16,624 hard copies and 10,605 e-copies distributed
- Promotional souvenirs: 666 items produced, and 391 items distributed
- Promotion videos: 9 titles produced, and 75,311 online views
- SEAFDEC websites established: SEAFDEC Departmental websites had a total of 138,477 unique visitors, and 6,181 links from other websites
- Project websites: 6,134 unique visitors, and 109 links from other websites
- Social media administered by SEAFDEC: 43,056 followers, 233,030 engagements, and 2,399,944 reaches
- Participation in exhibitions and related events: joined 5 exhibitions with 97,107 visitors recorded at SEAFDEC exhibition booths and displays
- Official press statements released: 13 press statements released, and recorded 109 appearances of SEAFDEC in public media and websites

- Positions of the ASEAN-SEAFDEC Member Countries on the Proposed Listing of Commercially-exploited Aquatic Species into the CITES Appendices at the CITES-CoP19 were agreed at the Regional Technical Consultation (RTC) on Development of the ASEAN-SEAFDEC Common Positions on the Proposed Listing of Commercially-exploited Aquatic Species (CEAS) into the CITES Appendices on 30 August–1 September 2022.

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 303 issues of newsletters/serial publications, 135 titles of technical publications, and 19 audio-visual materials were acquired
- Cooperation and exchange of materials: sustained cooperation with 399 network libraries within and outside the region
- Dissemination of technical and promotional materials: 85 titles (with 12,520 copies) of technical materials, and 80 titles (with 22,047 copies) of promotional materials disseminated to target groups
- Accessibility of information materials: 5,904 downloadable materials, 770,599 downloads during the reporting year 2022, and 5 databases made accessible on SEAFDEC websites
- Institutional Repository: 7,236,198 access, 7,080,742 unique visitors; 607 titles of materials uploaded during the reporting year, 8,449 accumulated titles, and 786,521 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 3,924 visitors
- Participation of SEAFDEC officials in events organized by other organizations: 124 SEAFDEC officials participated in 113 events: 62 officials at regional/international levels (*34 in physical events and 70 in virtual events*), and 62 officials at national/local levels (*84 in physical events and 19 in virtual events*)
- Number of presentations made by SEAFDEC Staff at non-SEAFDEC events: 10 oral presentations in events at regional/international levels; and 3 oral presentations in events at national/local levels
- SEAFDEC events organized:
 - o International/regional meetings, seminars, workshops: 23 meetings with 1,014 participants (*13 physical events with 476 participants, and 10 virtual events with 538 participants*)
 - o National/local meetings, seminars, workshops, consultations: 18 meetings with 338 participants (*10 physical events with 224 participants, and 8 virtual events with 14 participants*)
 - o International/regional training courses: 18 courses with 293 trainees (*14 physical training courses with 201 trainees, and 4 online training courses with 92 trainees*)
 - o National, on-site training courses: 33 courses with 445 trainees (*25 physical training courses with 321 trainees, and 8 online training courses with 124 trainees*)

- o Study tours: 1 program with 32 trainees
- o Internships: 2 groups with 19 interns
- o On-the-job training: 1 college with 83 students
- o Internal meetings: 14 meetings with 504 participants (*12 physical meetings with 449 participants, and 2 virtual meetings with 55 participants*)
- Participation of officials from Member Countries in events organized by SEAFDEC:
 - o International/regional meetings, seminars, workshops (498 participants)
 - o National/local meetings, seminars, workshops, consultations (228 participants)
 - o International/regional training courses (185 trainees)
 - o National on-site training courses (318 trainees)
 - o Study tours (30 trainees)
 - o Internships (17 persons)
 - o On-the-Job training (83 students)
- Network and cooperation mechanisms established (now with 45 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 2022: USD 6,835,641 representing non-regular sources of funds for the activities of SEAFDEC (*USD 2,579,526 from agencies/institutions in the region and USD 4,256,115 from agencies/institutions outside the region*)

Strategy 4: Strengthening SEAFDEC capability in information-related activities

- Capabilities of SEAFDEC staff in senior administration and information officer enhanced through the Training on Strategic Human Resource Management and Business Leadership
- SEAFDEC staff enhanced their communication knowledge (through Training on USAID Communications Knowledge and Guidance Session)
- SEAFDEC staff enhanced their knowledge of reporting and communication including gender-sensitive (through Training on Program and Activity Results Reporting and Communication including Gender Sensitive Reporting)

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-third 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 18–20 October 2022 in Bali, Indonesia)

Table 1. Participation of Member Countries in SEAFDEC Events in 2022

Category	Participants from Member Countries (no. of persons)										
	Brunei Darussalam	Cambodia	Indonesia	Japan	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Viet Nam
SEAFDEC regional/international meetings, seminars, workshops	38	39	74	26	28	63	34	62	14	73	45
SEAFDEC national/local meetings, seminars, workshops, consultations	0	18	76	0	0	20	27	13	0	74	0
International/regional training courses	18	16	13	0	11	31	11	37	4	22	22
National, on-site training courses	4	1	10	1	0	14	31	150	0	100	7
Study tours	0	0	0	0	0	0	0	30	0	0	0
Internships	0	0	1	1	0	0	0	13	0	0	2
On-the-job training	0	0	0	0	0	0	0	83	0	0	0
SEAFDEC internal events	0	0	0	1	0	0	0	13	0	0	0
TOTAL	60	74	174	29	39	128	103	401	18	269	76

PROGRESS IN THE IMPLEMENTATION OF SEAFDEC GENDER STRATEGY IN 2022

The SEAFDEC Gender Strategy was approved by the 51st 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 2022 is 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, and women’s parking area
- Number of staff in the Human Resources Office system: a total of 481 staff (183 females and 298 males) at the SEAFDEC Secretariat and five Departments
- One (1) training course was organized on program and activity results gender-sensitive reporting and communication
- SEAFDEC staff participated in five events of gender-related training organized by other organizations

Strategy 2: Integrating gender in SEAFDEC programs and projects

- Gender-sensitive¹ programs/projects: 6 regional projects (out of 19) are gender-sensitive
- Stakeholders and participants involved in programs/projects of SEAFDEC: 2,181 stakeholders/ participants (880 females and 1,281 males) involved
- Gender-related events organized by SEAFDEC: 8 events, with a total of 196 participants (130 females and 66 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: 22 events, with 989 participants (426 females and 563 males)
 - o SEAFDEC national/local meetings, seminars, workshops, consultations, etc.: 18 events, with 338 participants (136 females and 126 males)
 - o International/ regional training courses: 18 courses, with 294 trainees (130 females and 164 males)

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

- o National, on-site training courses: 33 courses, with 445 participants (219 females and 226 males)
- o Study tours: 1 program with 32 trainees (14 females and 18 males)
- o Internships (group/persons): 2 groups, with 19 interns (9 females and 10 males)
- o On-the-job training (students): 1 college, with 83 students (45 females and 38 males)
- o SEAFDEC Internal Events: 14 events, with 504 participants (243 females and 261 males)

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

- Articles/papers/reports published and distributed: 4 titles, with 1,200 hard copies produced, 1,400 hard copies distributed, and 363 e-copies downloaded
- Presentation on the gender-related subjects at events organized by other organizations: two oral presentations

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

- Collaboration with three organizations by participating at the events, and providing inputs during the session.

**SEAFDEC REVENUES AND EXPENDITURES IN 2022****Un-Audited Abridged Consolidated Financial Statements
As at December 31, 2022 and 2021 (in US\$)**

	2022 (Un-audited)	2021 (Audited)
REVENUES		
Contributions from:		
Member governments	10,285,620	10,836,612
Other sources	486,518	195,614
Other income	639,756	1,026,856
Total Revenues	11,411,894	12,059,082
EXPENDITURES		
Operating and Capital Expenditures		
Research	3,473,758	3,794,833
Training	1,096,572	709,187
Information	449,032	537,291
Collaborative	134,575	114,541
Others	197,583	91,344
Administrative	4,150,619	4,003,425
Total Expenditures	9,502,139	9,250,621
SURPLUS (DEFICIT), For the year	1,909,755	2,808,461
FUND BALANCE, Beginning of year	17,500,849 ^{1/}	15,686,443
FUND ADJUSTMENT	(6,163)	(9,437)
FUND BALANCE, End of year	19,404,441	18,485,467 ^{1/}
REPRESENTED BY:		
ASSETS		
Current assets		
Cash and cash equivalents	19,480,868	19,049,694
Receivables and other receivables	689,660	365,724
Advance and deposits	27,863	24,407
Materials and supplies inventory	35,578	41,631
Fuel oil for vessels	174,825	145,004
Prepayments	9,069	170,895
Other Current assets	20,082	2,168
Total Current assets	20,437,945	19,799,523
Noncurrent assets		
Reserved budget for vessel periodic maintenance	262,962	337,841
Restricted bank deposit	5,395	5,581
Termination indemnity fund	2,108,939	2,235,012
Long-term investments	270,832	196,082
Other noncurrent assets	142,317	367,724
Total Noncurrent Assets	2,790,445	3,142,240
TOTAL ASSETS	23,228,390	22,941,763
Less: Liabilities		
Accrued payable	561,485	609,971
Contribution received in advance	759,166	932,793
Fund held in trust	131,459	356,010
Reserved budget for vessel periodic maintenance for M.V. SEAFDEC 2	262,900	322,510
Total Current Liabilities	1,715,010	2,221,284

	2022 (Un-audited)	2021 (Audited)
Provision for termination indemnity	2,108,939	2,235,012
Total Liabilities	3,823,949	4,456,296
NET ASSETS	19,404,441	18,485,467

Remark: ^{1/} The Difference of US\$ 984,618 (US\$ 17,500,849 – US\$ 18,485,467) 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 2022 (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	-	-	-	-	661,197	713,197	6.25
Japan	280,000	-	-	-	-	-	280,000	2.45
Lao PDR	6,500	-	-	-	-	-	6,500	0.05
Malaysia	21,500	-	-	-	613,862	-	635,362	5.57
Myanmar	22,500	-	-	-	-	-	22,500	0.20
Philippines	25,000	-	-	5,829,074	-	-	5,854,074	51.30
Singapore	13,500	-	-	-	-	-	13,500	0.12
Thailand	33,000	2,682,487	-	-	-	-	2,715,487	23.80
Viet Nam	26,000	-	-	-	-	-	26,000	0.23
Sub-total	499,000	2,682,487		5,829,074	613,862	661,197	10,285,620	90.13
Other Sources/Grant ^{2/}	-	405,573	-	80,945	-	-	486,518	4.26
Other Income	43,421	133,791	-	462,544	-	-	639,756	5.61
Total	542,421	3,221,851		6,372,563	613,862	661,197	11,411,894 ^{3/}	100%

Remark:

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

^{3/} Excluded contribution received for the year 2022 which supported from Fisheries Agency-Japan for the Japanese Trust Fund for the amount US\$ 1,550,361 (Excluded Japan-MRC = US\$ 280,000), and from UNEP/GEF Establishment and Operation of a Regional System of Fisheries Refugia in the South China Sea and Gulf of Thailand = US\$ 495,700

Un-audited Other Contributions Received by SEAFDEC in 2022 (in US\$)

Sources	Amount in US\$ ^{4/}
Japanese Trust Fund (excluded: Japan MRC = US\$ 280,000)	1,550,361
UNEP/GEF "Establishment and Operation of a Regional System of Fisheries Refugia in the South China Sea and Gulf of Thailand" (Fisheries Refugia Project)	495,700
Total	2,046,061

Remark:

^{4/} Other sources of contribution which are not reported in the SEAFDEC Financial Statements.

