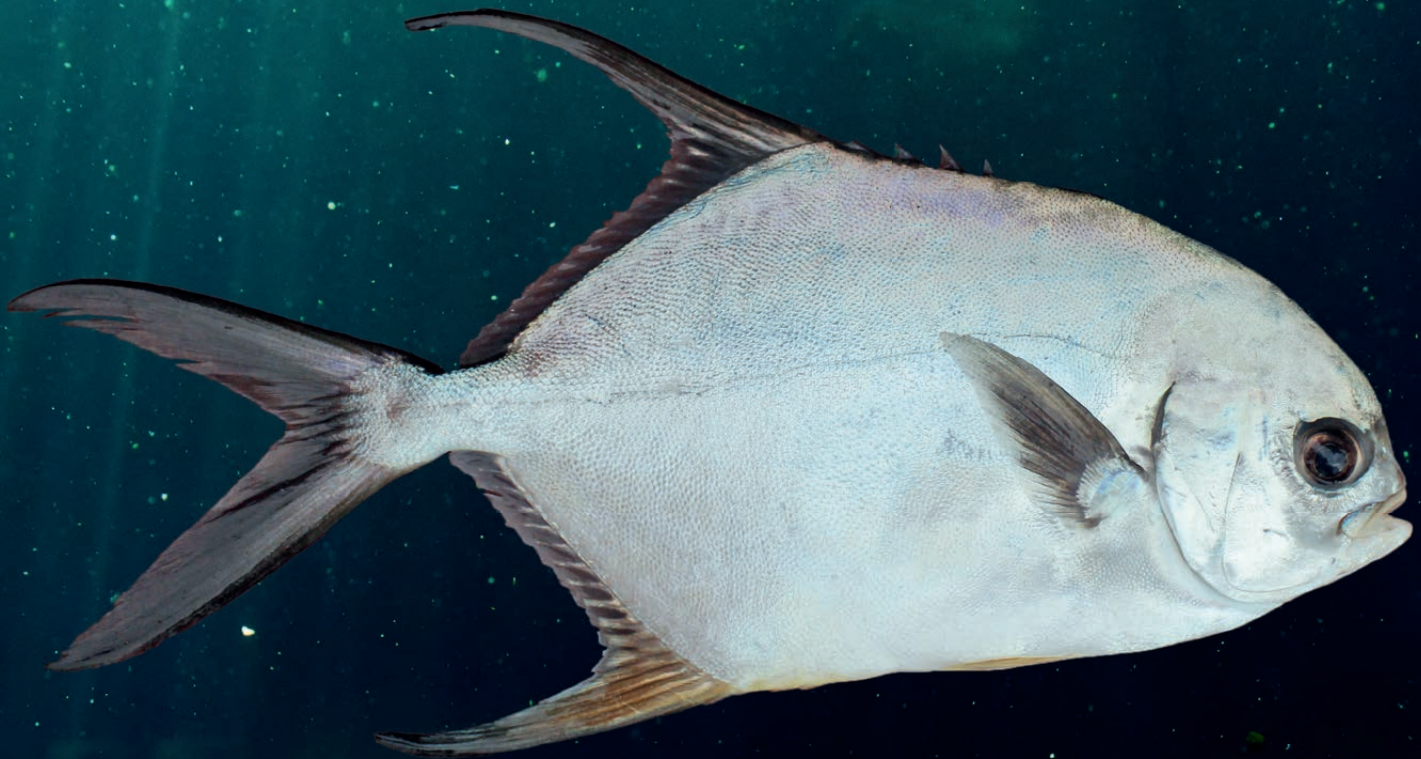




SEAFDEC/AQD HIGHLIGHTS 2022



ANNUAL REPORT
SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER
AQUACULTURE DEPARTMENT

MESSAGE OF THE CHIEF



In 2022, SEAFDEC/AQD continued to build on the successes of previous years, achieving significant milestones and marking remarkable progress in various areas.

One of our most notable achievements was the groundbreaking spawning and hatching of the round scad (*Decapterus* sp.), that we collected from the wild in December 2021. This marked the world's first documented spawning of fish. In January and February 2022, we successfully grew these larvae into fingerling sizes, another feat that had never been accomplished before.

Throughout the year, we continued to work on our over 50 research and development projects, striving towards their objectives, particularly with the easing of COVID-19 pandemic restrictions. Among these projects were three new studies conducted

in collaboration with the Japan International Research Center for Agricultural Sciences (JIRCAS) and their experts.

We also began to intensify our push for the farming of the snubnose pompano (*Trachinotus blochii*) which we believe has vast unrealized potential in Southeast Asia. We conducted numerous demonstration and production runs which, in 2022, netted over 22 tons of the prized commodity. Parallel to this, we began constructing a dedicated pompano hatchery at our Tigbauan Main Station to boost our seed production efforts.

In 2022, we completed the construction of a new Black Tiger Shrimp Broodstock Facility, which we already stocked with hundreds of new *Penaeus monodon* broodstock. This initiative aims to eventually produce our own broodstock and reduce our dependence on wild spawners, which are often carriers of diseases that are then passed on to their eggs and larvae.

Recognizing the importance of hands-on experience in aquaculture, we reopened our training program to offer face-to-face training courses. Out of the 27 training courses we organized, 25 were done in-person with participants coming in from all over the globe.

SEAFDEC/AQD also resumed traveling to different exhibitions to bring our technologies and information to our stakeholders. We held one exhibit each in the Luzon,

Visayas, and Mindanao regions of the Philippines. Additionally, we reopened the FishWorld Museum, which welcomed over a thousand visitors in 2022.

In December, we proudly hosted the back-to-back meetings of SEAFDEC, including the Forty-fifth Meeting of the SEAFDEC Program Committee (45PCM), the Twenty-fifth Meeting of the Fisheries Consultative Group of the ASEAN-SEAFDEC Strategic Partnership (25FCG/ASSP), and the Department Chief's Meeting. Our hosting helped provide a productive atmosphere for discussions and was also an opportunity for us to showcase our research and development activities to the delegates of our member countries and the rest of the SEAFDEC organization.

We view our achievements as stepping stones towards the numerous challenges that await us. With unwavering commitment and the invaluable support of our partner agencies and donors, we pledge to tackle these challenges promptly and diligently as we fulfill our mandate to undertake research, encourage human development, and disseminate and exchange information on aquaculture.

Dan D. Baliao
Chief, SEAFDEC/AQD

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Cover photo: Snubnose pompano (*Trachinotus blochii*) promoted anew by SEAFDEC/AQD for aquaculture in 2022

2022 RESEARCH AND DEVELOPMENT PROGRAMS

PRIORITY PROGRAMS OF SEAFDEC/AQD

Project Title
Fry Sufficiency Program
Development of Cost Efficient Feeds
<i>Oplan Balik Sugpo</i> (Operation Black Tiger Shrimp Revival)
Joint Mission For Accelerated Nationwide Technology Transfer Program (JMANTTP II)
Manpower Development

THEMATIC PROGRAMS

Study Title	Main Proponent	Collaborating Partners
Quality Seed for Sustainable Aquaculture		
1	The use of biofloc technology on mangrove crab larval rearing and indoor nursery culture	EGE Superio
2	Development of a protocol for large-scale culture of harpacticoid copepods for marine fish larviculture	MAE Mandario
3	Use of microalgal paste-fed <i>Proales similis</i> in marine fish larviculture: I. Refinement of <i>P. similis</i> mass production schemes II. Assessment of <i>P. similis</i> as first food for marine fish larvae	AV Franco
4	Nursery culture of mangrove crab <i>Scylla serrata</i> megalopae in pond-based net cage	P Caballero
5	Nursery and grow-out culture of snubnose pompano <i>Trachinotus blochii</i> in pond-based net cages	P Caballero
6	Use of andrectomized males (neo females) giant freshwater prawn (<i>Macrobrachium rosenbergii</i>) for the production of all-male progenies	MB dela Cruz
7	Optimizing the survival of laboratory-based seaweed <i>Kappaphycus alvarezii</i> propagule production by tank-based acclimation	HS Pitogo

Study Title		Main Proponent	Collaborating Partners
8	Development of a modified continuous culture system for the mass production of <i>Nanochlorum</i> sp. and <i>Brachionus rotundiformis</i>	MR de la Pena	
9	Mass production of mud polychaete <i>Marphysa iloiloensis</i> in indoor tanks	MAE Mandario	
10	Hatchery production of early juvenile sandfish <i>Holothuria scabra</i>	J Altamirano	
11	Mass production of all-male and mixed sex tilapia fingerlings and promotion of saline-tolerant tilapia	MB dela Cruz	
12	Seed production of donkey's ear abalone <i>Haliotis asinina</i>	SMB Ursua	
13	Seed production of freshwater prawn, <i>Macrobrachium rosenbergii</i> (De Man 1879)	EE Superio	
14	Mass production of mangrove crab (<i>Scylla serrata</i>) seedstock	EE Superio	
15	Sea-based nursery cage production of farmed eucheumatoids	JP Faisan Jr.	
16	Production of farmed Eucheumatoids by micropropagation in the land-based nursery	HS Pitogo	
17	Verification of adequate feeding rations and use of algal paste for single seed spat production of slipper-shaped oyster	MS Espino	
Healthy and Wholesome Aquaculture			
18	Cost effective ingredients blend of soybean meal, corn protein concentrate, poultry by-product meal, hemoglobin meal and protein enhanced copra meal in the diets of pompano, <i>Trachinotus blochii</i>	RE Mamauag	
19	Development and evaluation of fungi-fermented feed ingredients as alternative protein sources for milkfish or tilapia	JB Biñas	
20	Production techniques for culture of silver therapon (<i>Leiopotherapon plumbeus</i>) in tanks and cages	FA Aya	
21	Grow-out culture of abalone comparing the use of <i>Gracilariopsis heteroclada</i> and SEAFDEC formulated diet as feeds	MJHL Ramos	
22	Test of refined formulated feed for the grow-out culture of mangrove crab, <i>Scylla serrata</i> (Forsskal) in land based tanks	MB Teruel	
23	Treatment regimen on tissue culture seaweed plantlets affected by disease and epiphytic pest using commercially available chemicals	JP Faisan, Jr.	
24	Epidemiology of skin ulceration disease in juvenile and adult sea cucumber	RV Pakingking Jr.	
25	Refinement of <i>Scylla serrata</i> maturation diet	SS Avancena	

Study Title		Main Proponent	Collaborating Partners
26	Efficiency and profitability of Nile tilapia (<i>Oreochromis niloticus</i>) - giant freshwater prawn (<i>Macrobrachium rosenbergii</i>) polyculture in pond-based biofloc system with refinements on feeding rates	MB dela Cruz	
27	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>	GE Pagador	
28	Efficiency of polychaete phospholipid in promoting <i>Penaeus monodon</i>	SS Avancena	
29	Verification of probiotic supplementation in enhancing growth, survival and immune response of juvenile abalone <i>Haliotis asnina</i>	MS Espino	
30	Field verification of the vaccination regimen in cage-cultured marine fish species (pompano, snapper, grouper) broodfish in Igang Marine Station as a practical strategy to prevent the vertical transmission of nervous necrosis virus during seed production	RV Pakingking Jr.	
31	Culture of pompano <i>Trachinotus blochii</i> in floating net cages	RE Mamauag	
32	Demonstration of grow out techniques of commercially-viable shrimp species (<i>Penaeus monodon</i> and <i>Penaeus vannamei</i>)	RE Mamauag	
33	Evaluation of microbound diet for larval-stage mangrove crab, <i>Scylla serrata</i>	C Bendigosa	
Maintaining Environmental Integrity Through Responsible Aquaculture			
34	Field verification of mixed-diet in deep water grow-out culture of abalone using PVC tubes and recycled drums	MJH Leбата-Ramos	
35	Increasing technical skills supporting community-based sea cucumber production in Vietnam and the Philippines	JP Altamirano	ACIAR
36	Development of optimal fish-prawn co-culture schemes in tanks and lake-based cages for increased farm production: I. Use of genetically improved seedstock II. Evaluation of sustainable lake based tilapia-freshwater prawn farming innovations	MRR Eguia	
Meeting Social and Economic Challenges in Aquaculture			
37	Assessment and development of community-based sea cucumber (<i>Holothuria scabra</i>) farming livelihood for fishing communities.	RJG Castel	ACIAR

REGIONAL PROGRAMS

Sustainable Aquaculture through Cost-Effective Culture Systems and Prompt and Effective Aquatic Animal Health Management			
38	Surveillance and epidemiology of EHP (<i>Enterocytozoon hepatopenaei</i>) in Philippines	GE Pagador	GOJ-TF
39	Application of integrated approaches in the management of viral and other emerging diseases in brackishwater ponds	EC Amar	GOJ-TF

Study Title		Main Proponent	Collaborating Partners
40	Generation and application of optimized procedures in disease control and management against unknown and emerging crustacean and fish diseases in Southeast Asia; Subtitle I. Development of diagnostic procedures against unknown and emerging crustacean and fish diseases	LD de la Peña	GOJ-TF
41	Ecosystem approach to a responsible/sustainable farming for small scale farmer	EA Tendencia	GOJ-TF
42	<i>In vitro</i> and on farm investigation of organisms, chemicals, and methods to prevent or mitigate the effect of important shrimp diseases	EA Tendencia	GOJ-TF
43	Development of aquaculture techniques on new aquatic species (slipper lobster, <i>Thenus orientalis</i>) for promotion and creation of local aquaculture industry	SMB Ursua	GOJ-TF
44	Development of aquaculture technique on new aquatic species (kawakawa, <i>Euthynnus affinis</i> and shortfin scad, <i>Decapterus macrosoma</i>) for promotion and creation of local aquaculture industry	MIC Legaspi	GOJ-TF
45	Promoting anguillid eel culture in Southeast Asia through improvements in feeds and feeding, and health management	FA Aya	GOJ-TF
46	Promoting alternative feeds for sustainable production of freshwater aquaculture species	FA Aya	GOJ-TF
47	Developing community-based sustainable aquaculture livelihood strategies in Laguna lake and tributaries	ND Salayo	GOJ-TF

SPECIAL PROJECTS

48	Joint Mission for Accelerated Nationwide Technology Transfer Program for Aquaculture (JMANTTP-II) (Hatchery and grow-out technology for selected finfish, crustacean, mollusc and seaweeds)	DD Baliao	BFAR
49	Development of surrogation technique and genetic resource conservation system by transplantation and cryopreservation of germ cells in fish	T Okutsu	JIRCAS
50	Assessment and development of an Intermediate Culture System for tropical aquaculture species	R Nambu	JIRCAS
51	Improvement of larval settlement and post-larval production for abalone <i>Haliotis assinina</i> [sic] and sandfish <i>Holothuria scabra</i>	Y Matsumoto	JIRCAS
52	Identification of Tropical Anguillid Eels from Selected Natural Habitats in the Philippines using Environmental DNA Assay	MRR Eguia	
53	Pompano (<i>Trachinotus blochii</i>) production in brackishwater ponds	DD Baliao	
54	Mudcrab (<i>Scylla serrata</i>) farming in brackishwater ponds	DD Baliao	

Abbreviations used

ACIAR	Australian Centre for International Agricultural Research
BFAR	Bureau of Fisheries and Aquatic Resources
GOJ-TF	Government of Japan - Trust Fund
JIRCAS	Japan International Research Center for Agricultural Sciences

SEAFDEC/AQD PRIORITY PROGRAMS

ANNUAL REPORT 2022



Penaeus monodon broodstock at the new broodstock facility in the Tigbauan Main Station

Fry Sufficiency Program

The construction, operation, rehabilitation of hatcheries, and enhancing milkfish (*Chanos chanos*) breeder performance in collaboration with the Department of Agriculture's Bureau of Fisheries and Aquatic Resources (DA-FAR) aims to address the problem of seed insufficiency in the Philippines. For 2022, SEAFDEC/AQD focused mainly on two main components: revival of abandoned hatcheries and feasibility studies for legislated ones.

About 48 legislated hatcheries with a yield of 25 million fry per annum each were projected to be needed. These proposed hatcheries require about 3,750 milkfish breeders, 2,500 females and 1,250 males (2:1 female to male ratio). This program, on the other hand, also aims to break the stigma that captive-bred fry are inferior compared to wild-caught fry in terms of growth, morphology, and survival. These proposed hatcheries are also versatile and can accommodate other economically significant species such as the black tiger shrimp (*Penaeus monodon*), mangrove crab (*Scylla serrata*), and pompano (*Trachinotus blochii*).

This year alone, three feasibility studies were completed. The process includes assessing the suitability of pre-identified project sites, identifying the most suitable site, and creating the feasibility study report and other relevant documents.

Out of the sixteen proposed hatcheries agreed upon by SEAFDEC/AQD and DA-BFAR in 2019, the following have progressed from feasibility studies to actual construction: Lingig, Surigao del Sur, Sultan Naga Dimaporo, Lanao del Norte, Jabonga, Agusan del Norte, Del Carmen, Surigao del Norte, Hinatuan, Surigao del Sur, and Jose Dalman, Zamboanga del Norte.



Multi-species freshwater hatchery under construction in Jabonga, Agusan del Norte



Multi-species freshwater hatchery under construction in Jabonga, Agusan del Norte

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

Two abandoned hatcheries were also revived, repairs of tanks and training of hatchery personnel in culturing algae and natural food were made for Batad, Aklan. SEAFDEC/AQD also donated larvae onsite to jumpstart the rearing process. There are also ongoing repairs of tanks and maintenance of natural food cultures in Concepcion, Iloilo.

BANGUS FRY SUFFICIENCY PROGRAM: STATUS

As of November 2022

		FS PHASE	CONSTRUCTION PHASE
RA 10787	Lingig, Surigao del Sur	FS was done by AQD	97.3%
RA 10825	Surigao City, Surigao del Norte	FS was done by AQD	8.6%
RA 10825	Del Carmen, Surigao del Norte	FS was done by AQD	32.5%
RA 10813	Jabonga, Agusan del Norte	FS was done by AQD	91.6%
RA 10945	Perez, Quezon	FS was done by AQD	PHASE 1: 100%
RA 10858	Nasipit, Agusan del Norte	FS was done by DA-BFAR CARRAGA	0.00%
RA 10944	Hinatuan, Surigao del Sur	FS was done by AQD	32.3%
RA 10860	Sultan Naga Dimaporo, Lanao del Norte	FS was done by AQD	PHASE 1: 100%
RA 10859	Jose Dalman, Zamboanga del Norte	FS was done by AQD	26.0%
RA 10856	Bantayan, Cebu	FS was done by DA-BFAR 7	65.0%
RA 10939	Atimonan, Quezon	FS Pending	0.00%
RA 10948	Guinyangan, Quezon	FS was done by Guinyangan LGU	55.0%
RA 10950	Ligao, Albay	FS was done by DA-BFAR 5	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 LGU	94.0%

Development of Cost-Efficient Feeds

SEAFDEC/AQD made it a mission to rely less on fish-based ingredients, such as fishmeal and fish oils, to lower feed prices and improve the profitability of fish farms. In the past years, SEAFDEC/AQD partnered with DA-BFAR and 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. The production cost of the formulated feed was relatively lower than the price of most commercial feeds in the Philippines.

To test the effectiveness and efficiency of the feed, SEAFDEC/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 determine that feeds formulated by SEAFDEC/AQD

performed better against the commercial feeds, especially in terms of size and average body weight 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 for the formulated feeds was conducted for tilapia in a freshwater pond in Santo Tomas, Nueva Ecija. Results of the demonstration resulted in 1.9 tons of harvest after 146 days of culture. Another freshwater culture run was conducted in Taal Lake, which yielded another 1.9 tons of tilapia. Both runs achieved an FCR of 1.29.

More collaborators are in line for this technology-transfer pro-

gram, 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 the SEAFDEC/AQD team. Activities will begin in 2022 and continue until 2023.

SEAFDEC/AQD also proposed the establishment of a feed mill plant for the production of cost-effective feeds for commercially-viable finfishes. A 30 million budget, funded by the National Fisheries Program, 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 30 MT/day capacity and will produce all types of feeds for commercially-important aquatic species.

Oplan Balik Sugpo

SEAFDEC/AQD is collaborating with the DA-BFAR to address the decline in black tiger shrimp (*Penaeus monodon*) production in the Philippines. The initiative focuses on two main strategies: producing high-quality postlarvae (PL) and implementing improved grow-out culture.

In the hatchery phase, SEAFDEC/AQD established the Shrimp Hatchery Complex (SHC) at its Tigbauan Main Station in Iloilo, using spawners from the wild. The hatchery utilizes a spawner/broodstock facility used as a quarantine area. Newly-spawned eggs are washed with UV-sterilized seawater, disinfected with iodine, and rinsed with UV-sterilized seawater. Harvesting of the nauplii is based on the PCR test results of the spent spawners. Pathogen-negative nauplii are stocked in larval-rearing modules in the shrimp hatchery.

In 2022, the SHC successfully produced 600,000 disease-free black tiger shrimp fry. Some of the fry were stocked, for verification purposes, in the earthen ponds of the Dumangas Brackishwater Station (DBS) and at the HDPE-lined ponds of the National Fisheries Research and Development Institute (NFRDI) in Butong, Taal, Batangas. The remaining fry were sold to local buyers who wished to purchase the fry at Php 0.20–0.25 per piece.

For the grow-out phase, SEAFDEC/AQD collaborated with DA-NFRDI to implement environment-friendly culture protocols. HDPE-lined ponds were used for grow-out, incorporating biosecurity measures and biomanipulators (tilapia and milkfish). The verification run at DA-NFRDI yielded 659 kg of high-quality shrimp. The verification run at the DBS used earthen ponds, resulting in high growth



Inside the new Black Tiger Shrimp Broodstock Facility at the Tigbauan Main Station



New black tiger shrimp broodstock being processed before stocking in the broodstock facility

and survival rates.

Currently, SEAFDEC/AQD continues to make progress in brackishwater culture at its Dumangas Brackishwater Station. Upon collection of substantial data, aquaculture extension manuals on black tiger shrimp hatchery operations and grow-out culture in brackishwater ponds will be published.

In 2022, a newly built shrimp

broodstock facility in SEAFDEC/AQD's Tigbauan Main Station in Iloilo began operations. SEAFDEC/AQD will use the facility to jumpstart another area for research in establishing protocols in breeding Specific Pathogen Free (SPF) shrimp breeders.

JMANTTP II: Joint Mission for Accelerated Nationwide Technology Transfer Program

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

Seven on-site training courses were conducted in different parts of the Philippines between 2019 and 2021. Two of these were conducted online during the height of the COVID-19 pandemic. Requested topics of beneficiaries in Local Government Units include the biology and ecology of cultured species, hatchery-to-grow-out operations of freshwater and marine species, diseases, nutrition, biosecurity measures, among others. For on-site training courses, practical sessions were conducted on different culture techniques. These trainings include demonstration of proper water quality monitoring and feed preparations.

A course on grow-out operations of black tiger shrimp was conducted upon the request of DA-NFRDI in October 2022 at Butong, Taal, Batangas. The course was conducted to share the technologies developed through the *Oplan Balik Sugpo* program. Topics covered include the production of high quality shrimp fry in the hatchery, appropriate techniques applied in the grow-out phase, and the integration of biosecurity measures in every step of the operation. Twelve participants, composed of their Senior Science Research Specialists, Science Research Assistants, farm workers, and aquaculture technicians, participated.

Oplan Balik Sugpo program also



The selected pond site for pompano grow-out in New Washington, Aklan (top), and site for mangrove crab grow-out in Hamtic, Antique (bottom).

distributed science-based information on aquaculture techniques, collaborating with existing aquaculture farms to demonstrate aquaculture methods developed by SEAFDEC/AQD. The training aims to help farm owners and technicians implement aquaculture techniques on their own.

In 2022, a team from SEAFDEC/AQD conducted site assessments in the four provinces of Western Visayas, including Negros Occidental, Capiz, Aklan, and Antique. The suitability of these areas for the brackishwater pond grow-out culture of mangrove crab and pompano was assessed. For the sites to be suitable, they should have a manageable

pond with an area not more than one-hectare, good water quality, good water exchange, accessibility to farm inputs (feed, fry, and fertilizers), and available electrical power supply for the life support systems, such as pumps and paddlewheels.

Among the assessed sites, one 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 was found suitable for the grow-out of mangrove crabs within a mangrove area. Currently, these farms are undergoing rehabilitation and field demonstrations will begin in the first quarter of 2023.

Manpower Development

In 2018, sixteen 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 aquaculture. They were trained in shrimp and multi-species marine fish hatchery operations and cage and brackish-water pond culture operations. After three months of intensive training, they were employed by SEAFDEC/AQD and were assigned to the different areas and hatcheries at the Tigbauan Main Station.

Following the COVID-19 pandemic, another batch of trainees underwent intensive aquaculture training in 2021. The four graduates from different fisheries schools in Mindanao and Bicol area were previously screened and interviewed by SEAFDEC/AQD. They were exposed and trained rigorously on shrimp, marine fish, mangrove crab, giant freshwater prawn, oyster, and seaweed culture, as well as on the operations of brackishwater ponds and sea cages. Currently, they are assigned at SEAFDEC/AQD’s 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 of a rehabilitated milkfish hatchery in Songculan, Batan, Aklan between March and April 2022. 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.



Manpower development course practical training in pompano hatchery operations



Manpower development course practical training in pond culture

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

The search for the third batch of trainees for the Manpower Development course started last No-

vember 2022. Four graduates of the Bachelor of Science in Fisheries program of the University of the Philippines Visayas were accepted into 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 follow.

QUALITY SEEDS

ANNUAL REPORT 2022



Five-millimeter seaweed explants prepared for tissue culture as part of a project aiming to produce robust and fast-growing strains

Broodstock development

Giant freshwater prawn

In 2022, a study was done to verify the efficiency and cost of producing all-male giant freshwater prawns (*Macrobrachium rosenbergii*) through the removal of their androgenic glands. The aim was

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 po-

tential 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.

Hatchery & nursery protocols

Pompano

A study aimed 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 (higher body weight and 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 individual/m² (compared to densities between 0.3/m² and 0.7/m²) because of higher body weight and total biomass after 180 days. All treatments had similar specific growth rates and feed conversion ratios.

2022, one larval rearing run done showed higher survival in clear water and green water, while average weight was highest in biofloc water. In indoor nursery rearing experiments, two runs were conducted with inconsistent results. For the stress tolerance tests, biofloc water showed the best results. 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 de-

termine the ideal stocking density and culture period of mangrove crab megalopae in pond-based net cages. The study also aimed 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

Mangrove crab

A study evaluated the effectiveness of biofloc technology on mangrove crab (*Scylla serrata*) growth, survival, stress, and disease resistance. In 2021, the highest survival rate of crab larvae was in green water, followed by clear water and biofloc water. When reared in indoor nursery tanks, clear water had the highest survival rate, followed by either green water or biofloc water. In stress tolerance tests, biofloc water showed the best results. In

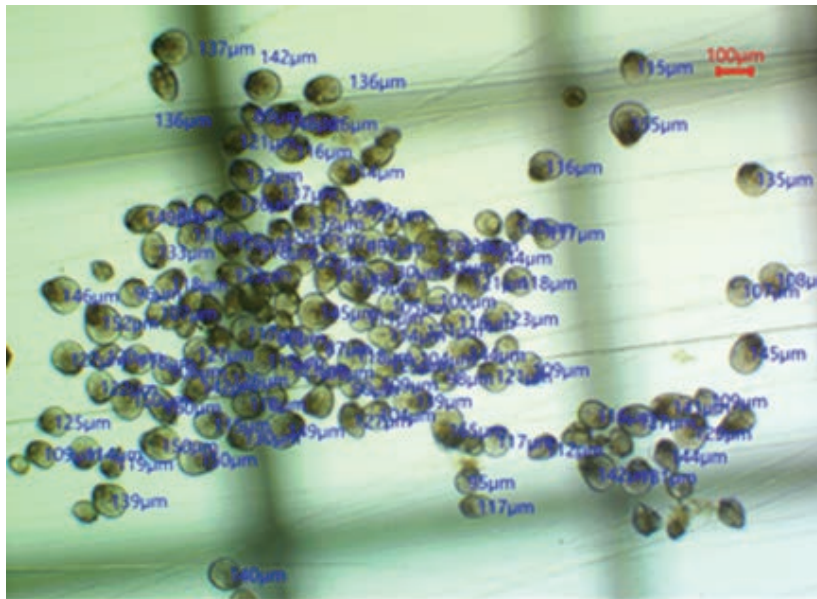


Logging the carapace width of a matchbox size crablet

results. Regardless of stocking densities from all trial runs, crab instar body weight ranged from 0.16 g to 0.46 g after 3 weeks and from 0.40 g to 1.12 g after 4 weeks. On the fourth week of culture, a stocking density of 50/m³ 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.

Oyster

A study aimed to investigate the best algal rations for oyster (*Magallana bilineata*) growth and survival during their larval and spat stages. The study used three feeding rations (low, medium, and high) at different larval stages and computed the rations based on the age, larval stage, and estimated number of larvae in each tank.



Measurement of oyster larval shell length under the microscope



Oyster spats

The results showed that the medium algal ration consistently produced bigger larvae compared to the low and high rations, but also had a rapid decline in survival rate at the onset of day 12. It was hypothesized that the decline in survival is due to the lack of cultch for the larvae to settle in. Different spawning techniques, such as thermal induction, overnight dessication, 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.

Seaweed

A study was done to produce tank-acclimated seaweed micropropagules. The study also hoped 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 of the study showed that tank acclimation is effective in increasing the survival and growth of propagules in the sea cage nursery system. Shortening the culture period of the seaweeds in the laboratory to 30 and 60 days likewise favors good growth.

Another study aimed to improve 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.

Sandfish

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



Tank acclimation of micropropagated seaweeds prior to stocking in sea cages and outplanting to farms

Alternative natural food

Mudworm

A study aimed to mass produce the polychaete *Marphysa iloiloensis* to support in-house research projects and crustacean hatcheries at SEAFDEC/AQD. The study also aimed to develop a protocol for the mass production of specific pathogen-free *M. iloiloensis*.

In 2022, polychaetes spawned 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 of hatchery-bred and wild polychaetes showed higher survival (78.62%) in the wild compared to hatchery-bred (43.4%). The growth and body length of hatchery-bred and wild polychaetes was not significantly different. It should



Modular tank setup for the grow-out culture of polychaetes

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 done 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.

Larval food

A study aimed 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 was 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.



Cyclopoid copepod under the light microscope

Rotifer

A study was done to determine the best feeding rate of centrifuged *Chlorella sorokiniana* paste for production of the rotifer *Proales similis*, and then determine the feeding rate of *P. similis* as first food in the larval rearing of small-mouthed marine fish.

It was determined that the best starting density to grow *P. similis* is 200 individuals/ml. *C. sorokiniana* feeding rate is best between 2.5×10^6 and 10×10^6 cells/ml, although the lower range is recommended for economic considerations. The best culture condition is the batch culture system with a black net or sack covering and using a 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 aimed to mass produce harpacticoid copepods (*Tigriopus* sp.) in large tanks for use as 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 should be conducted to further verify the results of larval rearing experiments.

Verification & demonstration of seed production technologies

Tilapia

A study was done to produce improved strains of Nile tilapia and red tilapia fingerlings for use by fish farmers. It also aimed 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 to 70,000 pieces of tilapia fingerlings per month. In 2022, a total of 414,700 tilapia fry were produced and 396,850 were sold to tilapia farmers. Lower production was attributed to the use of old and limited number of available broodstock in the hatchery.

Abalone

A study aimed 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, 56,367 abalone juveniles were produced. The experiment comparing mature abalones fed fresh seaweeds and maturation diet is ongoing. A feeding experiment showed that abalone juveniles fed seaweeds have better shell growth compared to those fed other diets, including refined and unrefined pellets and flakes, and the least growth was observed in those fed a mix of diatoms and *Spirulina* powder.

Mangrove crab

In 2022, the reproductive performance of mangrove crab broodstock were monitored. The crabs were collected from various sources including Aklan, Iloilo, Capiz, Masbate, Samar, Sorsogon, Surigao and Zamboanga.

Out of 235 broodstock, 198 died and only 89 crabs spawned. Zoea produced by each spawner ranged from 0.1 to 5.3 million.

Individual quarantine of broodstock were observed resulting to lower mortalities and higher likelihood of spawning. Erythromycin and Oxytetracycline prophylaxis were used to replace Furasolidone which was already phased out. From July to October 2022, trials using Erythromycin at 2 ppm (3 days on, 2 days off) produced encouraging results, with C1 survival rates ranging from 1.1 to 4.2%. The hatchery produced 332,938 crab instars and 8,040 megalopae which were distributed local farmers.

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 disposal to fish farmers. The study also aims to determine the cost analysis of prawn hatchery operations.

From January to October 2022, 72 prawn broodstock (average weight of 39.53 g) produced 1,511,075 larvae that yielded 174,063 postlarvae. No production was done in April due to a transfer to a new facility. Production from October to December were also hampered by larval mortalities due to unfavorable weather conditions.

Seaweed

A study sought to enhance the production of seaweed propagules by improving their survival. It also aimed to produce micropropagules for the sea-based nursery. The study will also provide cost-benefit analysis of the operations once data on the land-based nursery's 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 Igang Marine Station. Average survival of the *K. alvarezii* in the laboratory is 87.9%.

HEALTHY AND WHOLESOME AQUACULTURE

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Giant freshwater prawn harvested from a biofloc system after co-culture with tilapia

Aquatic Health Management

Control of pompano sea lice infestation

Sea lice (*Caligus* sp.) infestation poses a significant threat to pompano culture, necessitating effective treatment strategies. A field trial conducted from 2021 to 2022 evaluated the efficacy of emamectin benzoate (EMB), hydrogen peroxide, and freshwater baths in controlling sea lice on pompano. Experiments showed varying degrees of efficacy in controlling sea lice infestation in pompano.

In the freshwater bath treatment, sea lice prevalence decreased from 100% pre-treatment to 80% on the third day, and gradually increasing back to 100% towards the 21st day. The mean intensity of sea lice significantly decreased on the third day and gradually increased towards the 21st day. Adult sea lice were absent on the third day but reappeared on the seventh day in the treated group.

Hydrogen peroxide bath treatment yielded similar results, with significantly lower prevalence (65% and 45% for 1,500 ppm and 2,000 ppm, respectively) on the third day compared to full seawater as control (100%). Mean intensity decreased on the third day, starting to increase on the seventh day. Adult sea lice were absent on the third day but recurred from the seventh to the 21st day.

EMB, administered through in-feed treatment, led to a slight reduction in sea lice prevalence (85–95%) from the 14th to 35th day, while the control group maintained 100% prevalence until the 56th day. Mean intensity significantly decreased in the treated group, yet adult sea lice persisted up to the 56th day.

Vaccination of cage-cultured marine fish

Experiments aimed to determine NNV-neutralizing antibody titers in vaccinated and unvaccinated pompano broodfish. Marine fish, primarily vaccinated in 2020 with a first booster in 2021, exhibited detectable NNV-neutralizing antibody titers one- and two-month post-vaccination, peaking at month 3 but declining significantly by month 12. In 2022, A second booster was administered 12 months after the first, resulting in high antibody titers at two and three months post-vaccination.

NNV-neutralizing antibody titers in the sera of vaccinated fish collected at two and three months after the second vaccination were 1024 and 2432, respectively, while in unvaccinated fish, the titers were below 1:40. Data collection will extend until 2023.

The study also assessed NNV presence in milts and eggs of boost-

er-vaccinated and unvaccinated broodfish before spawning, finding negative RT-PCR results through 2022. Offspring from both groups exhibited no abnormalities or mortality at the Tigbauan Main Station hatcheries. Nearly a hundred high-value marine fish species, including pompano, grouper, sea bass, and snapper, reared in floating net cages at the Igang Marine Station, received first and second booster vaccinations as part of the study.

Epidemiology of the skin ulcerative disease in sea cucumber

A study was done to investigate the epidemiology of skin ulceration disease (SKUD) in hatchery-reared and sea pen-cultured sea cucumbers (*Holothuria scabra*), while also documenting occurrences in broodstock samples from the wild. SKUD in sea cucumbers often results from sudden temperature drops and high



Sampling of sea lice, *Caligus* sp. (inset), from a pompano breeder

stocking densities. The disease rapidly spreads from infected stocks to healthy ones making control difficult. A 2022 census noted the disease occurrences at the hatchery and the grow-out phases of sea cucumber culture.

In the hatchery phase, bacterial loads in larval rearing water were examined across two production cycles. No significant differences in heterotrophic plate count (HPC), presumptive *Aeromonas* count (PAC), and presumptive *Vibrio* count (PVC) were found, nor did physicochemical parameters significantly vary. Bacterial loads in the rearing water, sediment, and coelomic fluid of sea cucumber broodstocks reared in land-based tanks were also monitored. Notably, sea cucumbers with moderate to severe SKUD exhibited high bacterial counts in coelomic fluid, unlike apparently healthy ones.

Applying the same protocol to sea cucumbers in sea-based net pens, samples from the Igang Marine Station revealed 44 healthy, 9 mildly affected, and 8 moderately to severely affected individuals out of 61 examined.

Probiotic supplementation for juvenile abalone

A study was done to assess the potential of *Bacillus amyloliquefaciens* as a probiotic for improving the growth, survival, feeding efficiency, immune response, and overall cost of growing late juvenile abalone (*Haliotis asinina*). *B. amyloliquefaciens* was incorporated into the diet of juvenile abalone at different concentrations.

The experiment, spanning 180 days, involved plastic tanks stocked with early juvenile abalones. Two treatment groups received *Gracilaria* sp. enriched with different con-



Extracting hemolymph from abalone

centrations (Treatment 1: 105 cfu/ml and Treatment 2: 107 cfu/ml) of *B. amyloliquefaciens*, while a control group received seaweed soaked in UV-filtered seawater. Despite comparable weight gain, length gain, specific growth rate, and survival rate between treated and control groups, the treated groups exhibited a higher feed conversion ratio (FCR).

The immune response was evaluated by measuring the hemocyte count from extracted hemolymph of abalones. Treatment 2 (107 cfu/ml) showed a significantly higher hemocyte count than the control group, suggesting a potentially improved immune response.

However, probiotic supplementation through *Gracilaria* sp. pre-conditioning was deemed ineffective, possibly due to compromised palatability caused by a thick biofilm on the seaweed's surface. Future trials will explore modified delivery methods, such as incorporating probiotics into formulated abalone feeds.

Seaweed disease and pest detection

A study was done to evaluate commercially-available chemicals for treating seaweed plantlets in-

fecting with ice-ice disease (IID) and epiphytic filamentous algae (EFA), both before and after translocation. Tissue-cultured plantlets infected with IID and EFA were collected and preserved, and experiments were conducted at Igang Marine Station and Tigbauan Main Station.

In the immersion experiment using granulated chlorine (HICHLON 70; calcium hypochlorite 70%) at 400 ppm for 5 minutes (1-day treatment), EFA exhibited death through bleaching and complete detachment from host seaweed. Sodium hypochlorite (10% active ingredient) at concentrations of 200-400 ppm for 5 minutes (3-day treatment) resulted in EFA death and detachment. Hydrogen peroxide and citric acid at 400 ppm concentration for 60 minutes showed no significant results.

For IID-infected seaweed plantlets, an experiment with Povidone-iodine in concentrations ranging from 50 to 400 ppm for three consecutive days revealed preliminary results indicating the healing of infected tissues. However, the severity level of IID infection (<10%) might influence the treatment's effectiveness.



Epiphytic filamentous algae on seaweed plantlets before chemical treatment



Epiphytic filamentous algae on seaweed plantlets after chemical treatment

Aquaculture Nutrition

Pompano in floating net cages

Pompano is considered one of the most desirable and high-value food fishes; however, technical details on cage culture protocols could be more extensive. A study was done to verify the ideal stocking density, 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 x 5 x 3 m cage at 2,500 ind/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 x 5 x 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 pompano was also determined by incorporating the optimum feeding rate and stocking density in the experiments. 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 through 2023.

Cost-effective ingredient blend for pompano diets

An ongoing study was done focusing on the development of a cost-effective formulation for pompano grow-out in sea cages by replacing fish meal protein with alternative sources, including plant (soybean, corn protein concentrate, and PECM) and animal by-products (poultry by-product and hemoglobin meal). Initial data indicates that the alternative protein blend has lower performance parameters compared to the control diet, prompting ongoing reformulation efforts.

In a feeding experiment, pompano juveniles were stocked in floating net cages, and efforts



Pompano being sorted after harvesting from the floating cages of Igang Marine Station

were made to determine the optimal inclusion level of corn protein concentrate. Results suggested that corn protein concentrate could replace fish meal up to 20% inclusion level, but further increases significantly impacted performance parameters.

Subsequent experiments focused on the effect of enzyme inclusion in dietary treatments containing more than 20% corn protein concentrate. Diets were supplemented with Ronozyme Hi-Phos L (phytase source) and Ronozyme Multi-grain L (xylanase and glucanase sources). However, the results indicated that enzyme addition did not improve fish body

weight gain. Ongoing work includes assessing the digestibility of diets and ingredients in all dietary treatments.

Fungi-fermented feed ingredients

A study was done to explore the utilization of fermented non-conventional feedstuffs, including locally available forage plants, namely “ipil-ipil” (*Leucaena* sp.) and “madre de cacao” (*Gliricidia* sp.), and an aquatic plant (*Azolla* sp.). These plants were fermented with the fungus *Aspergillus oryzae* and evaluated for their effect on the growth and survival of tilapia.

Fermented plant meals were incorporated into iso-nitrogenous and iso-lipidic fish diets at increasing levels. Fermented “ipil-ipil” leaf meal (FIILM) replaced up to 71.4% of soybean meal, while fermented “madre de cacao” meal (FMDCM) and fermented *Azolla* meal (FAZM) replaced up to 53.4% of soybean meal. The diets were fed to tilapia fry for eight weeks in three feeding trials.

Results indicated no significant difference in fish survival across treatments, with survival rates ranging from 67% to 100%. In Trial 1, the highest growth rates were observed with 17.5% FIILM, but tilapia tolerated up to 35% FIILM without compromising growth. Trials 2 and 3 showed that up to 32% of FMDCM and FAZM could be included in tilapia diets without hindering growth.

The study concluded that fungi-fermented leaf meals, specifically FIILM at levels not lower than 30%, could effectively replace traditional protein sources in tilapia diets, offering a cost-effective and sustainable alternative.

Silver therapon culture in tanks and cages

The silver therapon (*Leiopotherapon plumbeus*) stands out as a valuable native freshwater species in the Philippines, offering a promising avenue for sustainable aquaculture in lake-shore communities. In the pursuit of optimal growth and survival during juvenile farming, experiments were conducted to determine basic nutrient requirements and develop suitable diets for silver therapon.

A series of trials were done involving the formulation of six experimental diets with varying levels of dietary lipid, with Danish fish oil as lipid source. It was found that a 12% lipid content produced

the best growth response and feed utilization. High survival rates were consistently observed across all dietary groups. Further investigations to estimate the optimal lipid requirement using regression analysis will be done.

The study extended to tank- and lake-based cage feeding trials to ascertain the ideal stocking density for silver therapon grow-out. In tank-based trials, mean body weight, weight gain, specific growth rate, feed efficiency, and survival rates did not significantly differ among stocking densities after 14 weeks of culture. However, mean percent weight gain and specific growth rate were higher at 15 and 30/m² stocking densities. Conversely, the lake-based cage trial, conducted over 12 weeks, indicated significant differences in growth parameters. Fish at 30/m² and 45 fish/m² stocking densities outperformed those at 60/m² and 75/m² in terms of mean body weight, weight gain, specific growth rate, and feed efficiency.

Polyculture of tilapia and giant freshwater prawn in biofloc system

A study was to evaluate the efficiency and profitability of Nile tilapia and giant freshwater prawn (*Macrobrachium rosenbergii*) polyculture within a biofloc system, with a specific emphasis on satiation-based feeding rates for tilapia while keeping prawn stocks unfed.

Masculinized tilapia fry and prawn postlarvae were stocked at 6 pieces/m² per species in a polyculture system. Physicochemical water quality parameters were regularly monitored, revealing desirable ranges, except for salinity in the first week, which was addressed by a 50% water change.

In terms of growth perfor-



Harvested tilapia that was polycultured with giant freshwater prawn in a biofloc system

mance, tilapia reared in polyculture in a biofloc system at 100% satiation exhibited the highest average weight gain (AWG) at 41.83 g, followed by traditional tilapia rearing at 100% satiation (39.43 g), and the lowest AWG was observed in the traditional method at 50–70% satiation (39.96 g). A similar trend was observed in absolute growth rates. For prawn, the highest AWG occurred in the biofloc system at 100% satiation (1.95 g), followed by the same system at 50–75% satiation (1.74 g). Traditional polyculture at 50–75% estimated satiation showed less promising results in terms of AWG for both species.

Refinement of mangrove crab maturation diet

A new study was initiated in the last quarter of 2022, aiming to improve the reproductive performance of mangrove crabs by refining their broodstock maturation diet. The study started by formulating the crab maturation diet using varying combinations of protein and lipid levels which were subse-

quently confirmed through proximate composition analysis. The water stability of feeds was also tested, and reformulations made to improve stability. Feed palatability and attractability tests are ongoing.

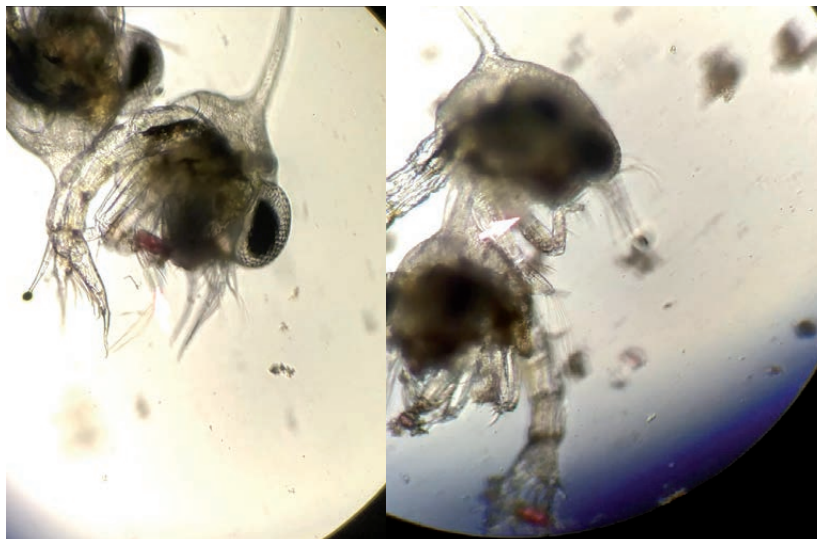
Refined formulated feed for mangrove crab

A study was conducted to enhance the sustainability of the mangrove crab (*Scylla serrata*) industry with the refinement of existing viable aquaculture feeds. Refinement was done by using more affordable ingredients and following the existing nutritional requirements and physical properties of mangrove crabs. The formulation involved the use of mussel meat and cholesterol for improvement of the molting processes.

The refined mangrove crab feed formula achieved 50% protein and 6.47% fat with an approximate cost of Php 116.00/kg (USD 2.11/kg). The feed was stable (54.30%) even after 24 hours submersion in water. Further, the refined feed exhibited high apparent protein digestibility coefficient (APDC) at 93.7%.



Rectangular maze (top) and Y-maze systems used to test the attractability and palatability of refined mangrove crab formulated diets



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

Attractability and palatability tests using the Y-maze and rectangular maze systems demonstrated and out-performed a commercial feed with faster physical attraction and consumption time noted with the refined feed after six hours. This land-based tank experiment confirmed the efficacy of the refined feed given to mangrove crabs. The high growth rates and survival of mangrove crabs when fed the refined feed solely would attest to the efficiency of the said feed.

Microbound diet for mangrove crab larvae

The study investigates the potential of improving the survival of mangrove crab zoea through the addition of enzymes to Microbound Diets (MBD). MBD are ideal food for larval rearing, but their sole use 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.

Initial preparations of sample MBD were conducted, and the feeding behavior of *Scylla serrata* zoea 1 was observed. Contrary to published generalizations that they encounter food by chance, zoea 1 actively approached areas in the water column where both rotifers and MBD were present. The zoea 1 fed with MBDS tended to be at the bottom, creating currents 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.

Two pigments, chromic oxide and fluorescent Phloxin B, were incorporated into MBD to confirm ingestion. The Phloxin-dyed MBD allowed for observation under a brightfield microscope, revealing that larger-sized MBD was grasped

by the zoea during feeding, but the food remained outside the mouth. Smaller MBDs embedded in a floc were manipulated by the zoea, but ingestion remained unclear. Under a fluorescent microscope, no feeds were found in the zoea's intestines after two hours of feeding with Phloxin-dyed MBD, indicating limited ingestion. Unfortunately, 50% larvae mortality occurred after exposure to the dyed MBD for two hours.

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.

Polychaetes for black tiger shrimp maturation

A study aimed to verify the efficiency of polychaete phospholipids in improving the reproductive performance of tiger shrimp, *Penaeus monodon*. The first part of the research was the extraction of polychaete polar lipid fraction (PLF). 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 three types of extracts.

Two sources of phospholipid will be tested in the study: polychaetes and krill.

The process of PLF extraction from freeze drying to the final extracted PLF of approximately 4 g took one month. Approximately ≥ 25 g of polychaete and krill PLF were produced. Tiger shrimp broodstock stocking was done in the last

quarter of 2022 with the rest of the experiment to be done in the following year.

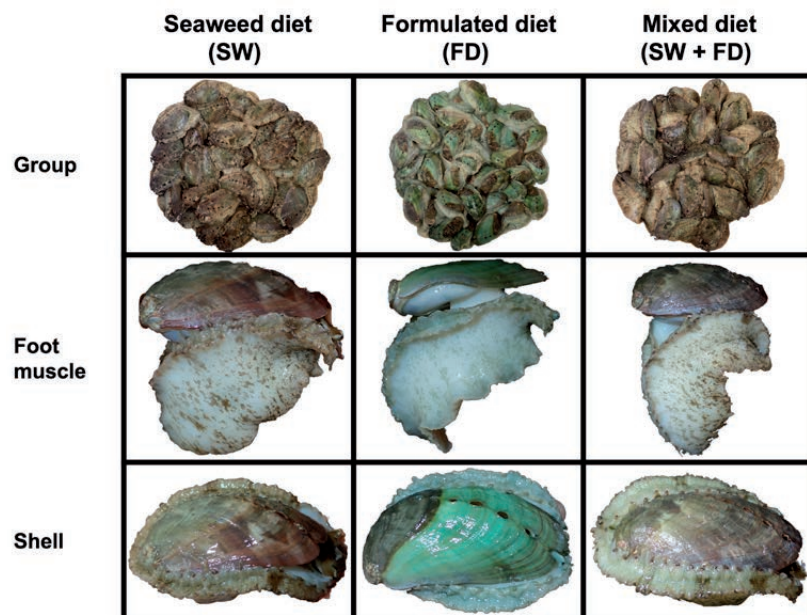
Alternative diet for abalone grow-out

In 2022, a study comparing seaweed (*Gracilariopsis heteroclada*) and a formulated diet by SEAFDEC/AQD as feed for abalone in grow-out culture concluded with consistent results. Preliminary findings from earlier experiments indicated that abalone fed with mixed diets (a combination of seaweed and formulated diet) exhibited significantly larger size and higher weight compared to those fed with seaweed alone or the formulated diet alone.

The final sampling, conducted at the 10th month of the culture period, reaffirmed the earlier results. Abalone fed with mixed diets demonstrated the highest

mean shell length and body weight (45.90 mm, 22.80 g), followed by seaweed-fed abalone (43.47 mm; 18.25 g), and lastly, formulated diet-fed abalone (41.78 mm; 15.76 g). Growth rates, both in length and weight, were significantly higher in abalone fed with mixed diets, and survival rates remained consistently high throughout the culture period.

Feed conversion ratios (FCR) were significantly lower in abalone fed with mixed diets and formulated diets compared to those fed seaweeds. The body weight to shell length ratios (BW:SL) increased over the experiment, with the highest ratio observed in abalone fed mixed diets. The study concludes that a mixed diet of formulated and natural components is the most effective feeding regime for abalone. Additionally, proximate analysis of abalone tissues was carried out before and after the experiment.



Abalone (*Haliotis asinina*) fed with different diets

MAINTAINING ENVIRONMENTAL INTEGRITY

ANNUAL REPORT 2022



Experimental pens for sandfish intermediate culture by JIRCAS with on-site weather monitoring system.

Culture of abalone in recycled containers

In 2022, a study was conducted to scale up abalone (*Haliotis asinina*) culture using recycled containers (drums) and compare their growth and survival with those cultured in PVC tubes. Culture containers containing abalone were suspended 10 m deep in the water column from a bamboo floating raft. Abalone were fed alternately with the seaweed *Gracilariopsis heteroclada* and flaked formulated diet.

From the first sampling in July until December 2022, results showed that monthly mean shell lengths and body weights were consistently and significantly higher in abalone cultured in pipes than those in recycled drums. Additionally, survival was consistently higher in abalone reared in PVC pipes than in drums, with significantly higher survival in November and December 2022.

e-DNA identification of anguillid eels

An attempt was made in 2022 to identify tropical anguillid eels in select natural habitats in the Philippines using environmental DNA (e-DNA) assay. e-DNA analysis is used in detecting the presence of species in known and unknown aquatic habitats without the need for obtaining actual animal tissue. 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 op-



Stocking of abalone in PVC tubes at the Igang Marine Station



Passive sampling of anguillid eels at Aparri province using improvised sampling grid with membrane filters

timized and confirmed to work using water samples from eel culture tanks at the Binangonan Freshwater Station. Initial active samplings along 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 hours in the sampling sites. Results of samples from the December 2022 field sampling showed positive results from those collected passively in Aparri, but not in Baggao, along 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.

Sea cucumber production

In 2022, various research and activities related to sandfish (*Holothuria scabra*) production continued at SEAFDEC/AQD, with funding support from ACIAR (FIS-2016-122). To determine the optimal microalgae species and combination in larval rearing of sandfish in the hatchery, microalgae experiments were done using SEAFDEC/AQD's 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 a.m. and 4 p.m. achieved the highest growth.

The influence of biofilm in ocean nursery production of early juvenile sandfish was assessed. A floating nursery was set up at the Igang Marine Station and stocked with sandfish spats in 12 nursery hapas. Biofilm samples will be collected and investigated. Initial 30-day data shows that average wet body weight was at 1 gram with a survival 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's PrimoAlga concentrated algae 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, 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



Bathymetry survey of potential sea ranch sites at Molocaboc Island



Successful sandfish early juvenile production by MOSRA members using microalgae concentrate as larval food at the island-based hatchery in Molocaboc Island

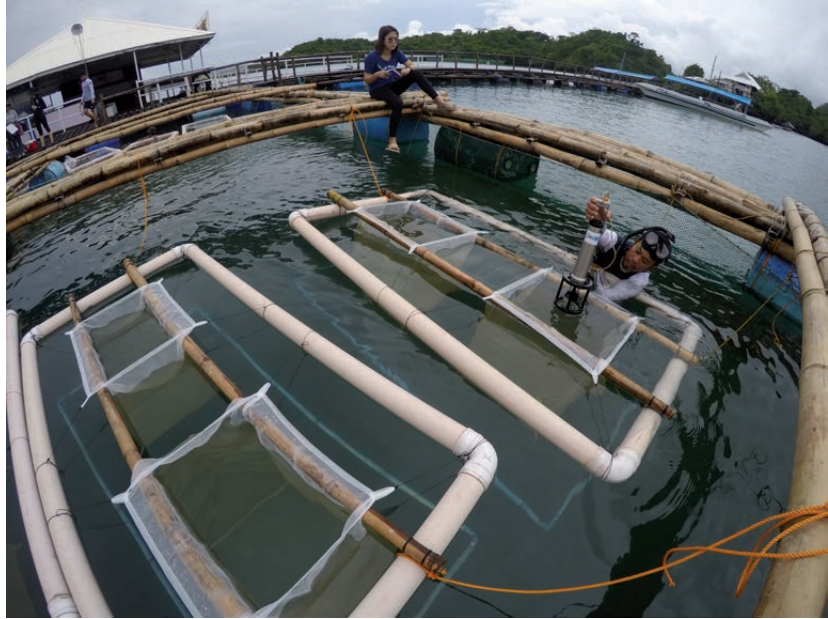
45 days, results indicated that sandfish preferred to bury around the corners of culture tanks that were shaded. There was also a significant preference to bury where artificial shelters were placed.

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 show that the type of pen does not affect sandfish growth until the ninth month where 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 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 socio-economic criteria. In July, two experimental grow-out pens were constructed in each of the expansion sites. Monitoring of sandfish growth and survival is ongoing.

Intermediate culture system

Funded by JIRCAS, a study continues to develop an Intermediate Culture System (ICS) for aquaculture species. Sandfish was chosen



Water quality monitoring at the sandfish nursery at the Igang Marine Station

as a pilot commodity with the aim of growing them from fingerling size (>2 g) to late juvenile sizes of at least 20 grams. The approach involves comparing potential culture sites with different environmental conditions using the sea-based pen culture system, aiming to determine the best mix of parameters for optimal sandfish growth, survival, and culture duration. Systems Dynamics Modelling (SDM) was employed to evaluate and refine the ICS.

A floating hapa experiment was conducted at the Igang Marine Station (IMS) to determine the target stocking weight for intermediate culture in pens. Different stocking densities are tested, and monthly monitoring reveals that lower

density treatments result in higher average body weight (ABW), while high-density treatments exhibit the highest survival rates.

Fouling within hapas is observed, with a diverse group of organisms (algae, seaweed, bivalves, gastropods, etc) growing alongside sandfish. Water parameters are measured throughout the experiment, and a decrease in ABW is linked to drastic changes in habitat environment, such as a decrease in water temperature and salinity due to heavy rain.

The installation of culture pens and loggers for intermediate culture at IMS is complete and awaiting the availability of the target size of sandfish juveniles for stocking.

MEETING SOCIAL AND ECONOMIC CHALLENGES

ANNUAL REPORT 2022



Women members of the Molocaboc Sea Ranchers Association (MOSRA) monitoring the sandfish juvenile stocks from nursery hapa nets.

Sea cucumber sea ranching

In 2022, a project funded by the Australian Centre for International Agricultural Research (ACIAR) aimed to assess the capacity of island-based communities to pursue a sea cucumber farming livelihood. An aspect of which seeks for strategies to improve the participation of fishing communities in the farming of sandfish (*Holothuria scabra*), specifically in the island of Molocaboc of Sagay City, Negros Occidental. A multi-method approach, combining qualitative and quantitative data collection was applied in focus group discussions, oral history interviews, and resource mapping activities. Results highlighted the roles of women and children as the main gleaners of sandfish in the community, hence, separate meetings and education, information, and communication (IEC) activities were focused on them as the most direct users of the sea cucumber resource.

Also, during this year, community awareness was improved with regards the local policies, regulations, and trade through participatory activities. Dialogues were made with the local traders and stakeholders to discourage purchasing of undersized sandfish. Such engagements encouraged the local barangay government to adopt the Philippine National Standard for sea cucumbers into a local ordinance, identifying that only harvestable size (>320 g) sandfish may be collected and sold.

Meanwhile, the family-based nursery rearing of sandfish in floating hapas were maintained and managed mostly by the women members of MOSRA. The buy-back scheme of the project ensures the local partners with some income



Resource mapping and IEC activities with women and children in Molocaboc Island, Sagay.

after one or two months of nursery culture. Production from these floating nurseries provide the needed juveniles that are released into the sea ranch for grow-out.

This year, the project also demonstrated the traditional processing of sandfish, using a 3-kg sample of fresh sandfish with sizes of 320–600 g. Although, this activity only produced an equivalent of 260 g of final dried product, the level of quality was appraised to be more than PhP 4,000 per kilo.

Furthermore, traditional knowledge of the Molocaboc community was incorporated into the decision-making process in the establishment of sandfish sea ranching expansion sites. Through focus-group discussions, local representatives of the Molocaboc Sea Ranchers Association (MOSRA) gave relative scores to a series of criteria to rank potential sandfish farming sites in terms of suitability. Merging with the results of the technical environmental surveys, two sites were identified and eventually declared in a barangay resolution. One is a 2,500 m² area

near the existing Community-based Resource Enhancement site, and another 3,000 m² seagrass area near mangroves, locally known as “Kang Atong”. Experimental sandfish pens (20 m x 20 m) were constructed within each site and stocked with larger sandfish (>150 g) for trial grow-out.

The project’s IEC and training activities in various aspects of sandfish production – from the hatchery, nursery, grow-out, and processing of sandfish – enhanced awareness about the realities and best practices in growing, processing and trading of sea cucumbers. Furthermore, the active engagement with the local community has ignited the growing interest of many, including the women members, to participate further in various activities, not only in the hatchery and nursery aspects, but also in the active monitoring of sandfish stocks and guarding of the sea ranch sites, which were only originally participated in by men.

REGIONAL PROGRAMS FISH HEALTH & SUSTAINABLE AQUACULTURE

ANNUAL REPORT 2022



Shortfin scad, hatched and grown to 48 days at SEAFDEC/AQD

Aquatic health management

Epidemiology, distribution, occurrence, and prevalence of EHP

Enterocytozoon hepatopenaei (EHP) is a microsporidian parasite affecting shrimp, causing growth retardation and posing a significant threat to the shrimp industry. This study aimed to investigate the epidemiology, distribution, and prevalence of EHP, as well as understand its transmission mechanism in shrimp populations. Conducted in 2021 and 2022, the research focused on the provinces of Iloilo and Zambales in the Philippines, with a total of 1,078 and 1,302 shrimp samples analyzed, respectively.

During the wet and dry seasons of 2021, active surveillance faced challenges due to COVID-19 travel restrictions. Nevertheless, shrimp samples from hatcheries were examined for EHP using wet smear, nested-polymerase chain reaction (PCR), and histological analysis. Results revealed EHP prevalence in grow-out shrimp at 11.3%, while hatchery-reared shrimp showed no EHP presence. In 2022, seven farms and three hatcheries were assessed for the presence of EHP. Three farms were located in Zambales, located in Central Luzon of the Philippines, while the rest of the farms and hatcheries were located in the Visayas Region. Of these, 5.3% of grow-out shrimp were found affected, with no EHP found in hatcheries. Notably, EHP prevalence varied between dry and wet seasons, with 2021 showing occurrences in both seasons, while 2022 recorded EHP only during the dry season.

The study identified specific farms, such as in the towns of Ajuy,

Dumangas, and Masinloc, with EHP-positive shrimp. Despite variations in prevalence, PCR analysis of pond soil from sampled farms in 2021 and 2022 yielded negative results. Wet mount analysis in 2021 proved inconclusive, while ongoing histological analysis of PCR-positive samples aims to provide further insights into EHP characteristics. The collected data will be compiled into guidelines and management measures to combat EHP's impact on the shrimp industry.

Managing viral and other emerging diseases in ponds

In shrimp aquaculture, the success of farming operations hinges on the growth and survival of the species, influenced by the occurrence of disease outbreaks. This study explores a multifaceted approach to disease management in the cultivation of *Litopenaeus vannamei* (whiteleg shrimp) in brackishwater ponds. In 2022, pond soil and water disinfection were tested, along with the use of postlarvae from specific pathogen-free broodstocks.

The experimental setup involved two types of trial tanks – disinfected and non-disinfected – to assess the efficacy of pond management against the white spot syndrome virus (WSSV). The soil and water were subjected to quantitative polymerase chain reaction (qPCR) analysis to detect WSSV, and shrimp postlarvae (PLs) were tested after stress induction to ensure detectable pathogen levels. PLs with negative qPCR results were stocked in the disinfected tank, while the opposing tank was deliberately infected with WSSV.

Commercial probiotics were applied following the manufacturer's protocol, and shrimp growth and development were monitored throughout the 60-day culture period. Results indicated that PLs from specific pathogen-free (SPF) broodstocks in disinfected tanks exhibited superior growth (2.73 g in weight, 7.98 mm in length) and survival (68.5%) compared to non-disinfected ponds (2.29 g in weight, 7.57 mm in length, and 61.5% survival).

The study's next phase involves testing new disinfection protocols using 40 ppm chlorine for seven days and drying the soil to 5% moisture. This comprehensive investigation contributes valuable insights into optimizing disease management strategies for sustainable shrimp aquaculture.

Developing diagnostic procedures against crustacean and fish diseases

Monitoring and surveillance of mass mortalities in aquaculture, attributed to unknown crustacean and fish diseases, is done with the aim to isolate and identify causative agents and subsequently formulate disease diagnostic protocols.

In 2020 and 2021, the project examined three farms that experienced mass mortalities and identified a potential bacterial causative agent. In 2022, monitoring continued, and a *Litopenaeus vannamei* shrimp farm in Zarraga, Iloilo reported mass mortalities and tested positive for WSSV despite stringent biosecurity measures. Bacteriological analysis revealed

high presumptive *Vibrio* counts. Intervention, including probiotics and immunostimulants, led to PCR-negative WSSV and AHPND results, that resulted to a successful stock harvest.

A *Penaeus monodon* grow-out farm in Dumangas, Iloilo, also underwent monitoring. Despite robust biosecurity, high bacterial counts were observed, potentially linked to probiotics. Fifty-three isolates were identified, with prevalent species in the shrimp samples being *Vibrio mytilii* (7%), *Serratia fonticola* (7%), *V. hispanicus* (7%), and *V. mimicus* (7%). In water samples, prevalent species 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.

The project extended its scope to develop and optimize disease diagnostic protocols for emerging diseases, namely Decapod Iridescent Virus (DIV1) and Mud Crab Reovirus (MRCV).

Ecosystem approach to responsible and sustainable shrimp farming

The study explores the feasibility of clustering or zoning in aquaculture through the design of an artificial wetland using identified aquatic organisms to minimize disease risk. The mesocosm experiment, conducted in 2022, utilized a recirculating aquaculture system with four interconnected tanks to simulate an artificial wetland. The tanks had three compartments: one for shrimp culture, a reservoir, and a treatment compartment stocked with *Holothuria*, *Caulerpa*, or *Gracilaria*.

Results from four replications revealed no significant differences in shrimp survival, weight gain, and carapace lengths between the three types of organisms stocked in the treatment compartment. However, *Holothuria*-treated water exhibited the highest shrimp survival rate, while *Caulerpa*-treated water showed the best performance in weight gain and carapace length.

Shrimp bacterial profiles were analyzed, indicating variations in total heterotrophic bacterial count (TPC), luminous bacteria, *Vibrio parahaemolyticus*, *Vibrio cholera*, and *Vibrio alginolyticus* among treatments. Overall, there was no significant difference in the three organisms in terms of shrimp bacterial profile.

In terms of nutrient levels, tanks with *Caulerpa* and *Gracilaria* in the treatment compartment showed lower ammonia, phosphate, and total ammonium nitrogen (TAN) compared to control tanks. Similar trends were observed in shrimp tanks with *Gracilaria*-treated water having lower ammonia, phosphate, and TAN levels.

All organisms decreased in weight. Weight loss in the organisms varied, with *Holothuria* exhibiting the lowest (-7.35%), followed by *Gracilaria* (-9.51%), and *Caulerpa* experiencing the most significant decrease (-37.89%).

The mesocosm system's efficiency in small-scale shrimp farms will be done next, with site selection for further implementation.

Methods to prevent transmission of shrimp diseases

This study addresses the persistent issue of diseases affecting black tiger shrimp (*Penaeus monodon*) by exploring the efficacy of

various chemicals and methods in disinfecting fertilized eggs and nauplii against pathogens.

Two rounds of egg disinfection, using three concentrations (50, 100, and 200 ppm) of formalin, hydrogen peroxide, and detergent, were performed with four replicates per treatment. Hatching rates showed significant differences among disinfectants, with hydrogen peroxide exhibiting the lowest rates. The development of nauplii into mysis and postlarvae did not significantly differ between treatments, although lower percentages of nauplii that developed into mysis and from mysis to postlarvae were observed in those disinfected with hydrogen peroxide.

Three batches of both undisinfected and disinfected eggs were submitted for disease diagnosis, revealing no significant differences in the loads of white spot syndrome virus (WSSV) and infectious hypodermal and hematopoietic necrosis virus (IHHNV) among disinfected eggs, including the control. This suggests that detergent, hydrogen peroxide, and formalin (up to 200 ppm) are not effective against these pathogens, and increasing concentrations may adversely impact hatching rates and overall shrimp development.

For the nauplii stage, disinfection using three concentrations (50, 100, and 4,200 ppm) of formalin, hydrogen peroxide, and detergent was carried out. Acute hepatopancreatic necrosis disease (AHPND) was not detected in any treatment, indicating potential removal through rinsing with UV-sterilized seawater. The study aims to provide recommendations and guidelines for preventing shrimp disease transmission during the hatchery phase based on these findings.

Development of aquaculture techniques on new aquatic species

Slipper lobster

The scyllarid lobster (*Thenus orientalis*) is a highly sought-after seafood delicacy in the Philippines, commanding prices 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.

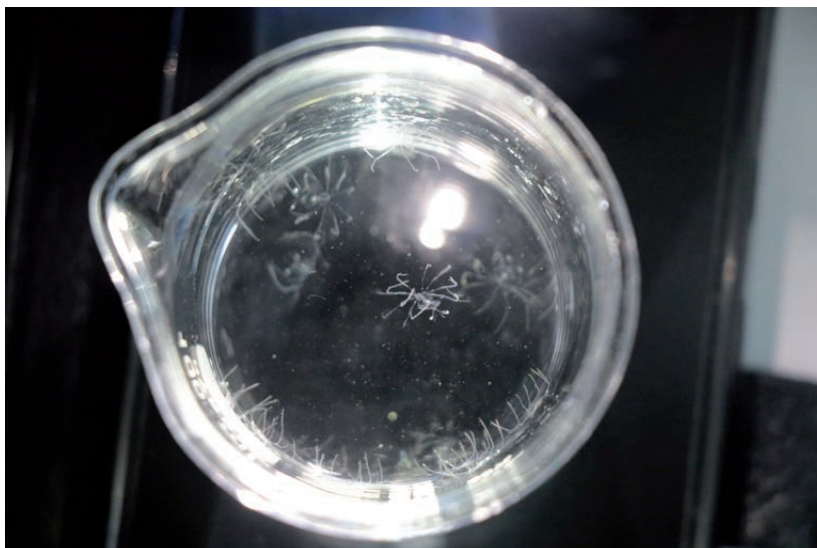
Collection of adult slipper lobsters from the wild continues as the study aims to develop an efficient transport protocol. In 2022, modifications were made to existing protocols, emphasizing the importance of acclimatization before tank stocking. New protocols include transporting only gravid females with eggs to minimize the number of animals during transport, and limiting collection to the season (July–November).

Egg coloration was identified as a useful indicator of embryonic development stages, with dark yellow or orange signifying fertilized eggs and a brown color indicating pre-hatching.

Observations revealed successful hatching of eggs spawned by slipper lobsters stocked in SEAFDEC/AQD's hatcheries. Spawners exhibited no mortality after hatching.

A feeding study for broodstock demonstrated active feeding on frozen squid and fish flesh, with a preference for “lobo-lobo” and squid over *Acetes* and mussels. Continued investigation will assess the slipper lobster's growth in total length and body weight.

Initial trials aimed to determine the appropriate culture vessel for phyllosomas, with 12-liter plastic



Phyllosoma larvae of slipper lobster



Slipper lobster broodstock collected from the wild

pails preferred for easy maintenance. A stocking density of 5 larvae/L was maintained, with mild aeration deemed crucial for phyllosoma activity. Mass mortalities occurred when water temperature dropped to 25–26 °C from the ambi-

ent 27–29 °C, prompting consideration of a water heater installation.

First foods offered to phyllosoma included *Brachionus*, *Artemia* nauplii, and *Nanochlorum* sp., with further verification required for conclusive results.

Kawakawa

The study on the culture of kawakawa (*Euthynnus affinis*), an economically important neritic tuna in Southeast Asia, continued in 2022. The research aimed to generate basic information regarding the feasibility of kawakawa culture. A total of 338 kawakawa samples were collected from January to December, excluding April and September. The samples included 45 females, 55 males, and 238 with undetermined gonads. Collection occurred monthly, with some interruptions due to typhoons affecting hauling operations.

Reproductive biology aspects were studied through gonadosomatic index (GSI) observations, with June and August showing the highest GSIs for females and males, respectively. Despite the low correlation due to an insufficient number of samples, it was observed that the fish size is directly proportional to the GSI, fecundity, and oocyte diameter. Gut content analysis revealed that mature and larger kawakawa were highly piscivorous, with anchovy, barracuda, and fish carcass being the predominant diet. On the other hand, juveniles preferred smaller fish, *Acetes*, shrimps, anchovies and water striders.

Handling trials were conducted for kawakawa transport from an otoshi-ami in Barbaza, Antique Province to SEAFDEC/AQD's Tigbauan Main Station. Conditioning and transport techniques were able to achieve a 100% survival rate, with smaller sizes found more suitable for handling and transport.

In tank management, kawakawa were maintained in 10-ton tanks, experiencing some mortalities attributed to elevated ammonia levels.

Despite encountered challenges, most kawakawa managed to



An otoshi-ami (left) nets shortfin scad and potential breeders are immediately stocked in a floating acclimation cage (extreme right)



Wild kawakawa that matured after 8 months in captivity for female (left) and 10 months for male (right).

grow to maturity in captivity. Histological analysis indicated a female attained mature size at eight months at 800 g with a 0.6 GSI, and a male at 10 months at 1,750 g with a 0.7 GSI. However, histological analysis revealed the female was still immature and the male was in a developing stage. Experiments to enhance transport protocols, broodstock management, nutrition, and disease monitoring are slated for 2023.

Shortfin scad

In 2022, the study on shortfin scad (*Decapterus* spp.) aimed to develop efficient transport protocols and enhance broodstock tank management. A total of 381 sam-

ples were collected from otoshi-ami setups in Barbaza and Tibiao, Antique, Philippines, between January and June. The study included morphometric measurements and reproductive biology investigations.

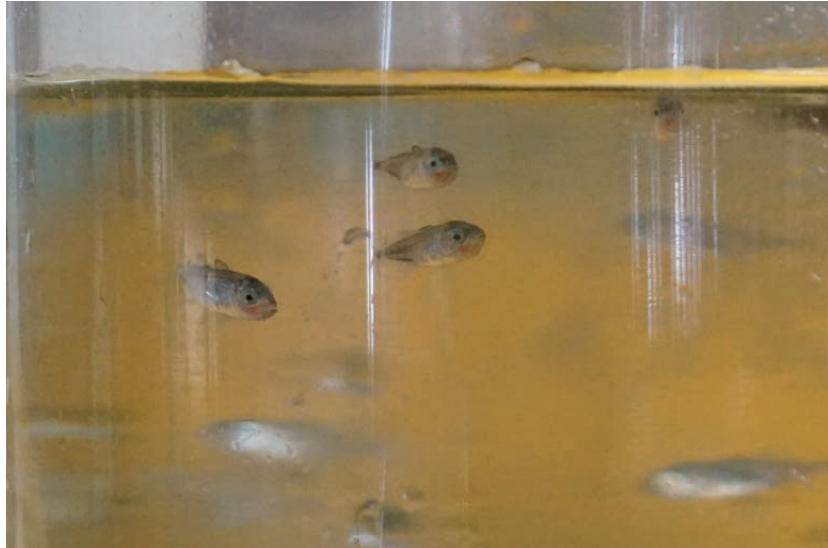
Reproductive biology findings revealed a pattern in gonadosomatic index (GSI) levels mirroring the increase-decrease pattern of average mean body weight, with mature females consistently exhibiting higher GSI compared to males in March, April, and June. Gut content analysis indicated that most samples had empty stomachs, with some containing small shrimp carcasses.

Handling trials for wild-to-tank transport involved pre-transport

conditioning in temporary fish cages and packing in oxygenated bags or customized transport tanks. Successful transport with high survival rates was achieved after three hours of transport.

Breeders were maintained in 10-ton tanks, covered with b-net, at SEAFDEC/AQD's Tigbauan Main Station. Regular draining and replenishment (70–80%) of seawater were done to prevent an algal bloom. The study compared shortfin scad (*D. macrosoma*) to redbtail scad (*D. kurroides*), revealing faster growth in shortfin scad during larval rearing.

Spawning episodes continued, with observations suggesting breeders could spawn on any day without a specific lunar rhythm. Monthly mean fertilization rates were highest in January 2022, while the highest mean hatching rate occurred in February 2022. Parasitic infections, including caligid parasites, isopods, and *Amyloodinium*,



Shortfin scad hatched at SEAFDEC/AQD, at 20 days old

were addressed through manual removal and freshwater baths.

An episode of parasitic infection caused high mortality during larval rearing trials, attributed to poor water quality. Bacterial monitoring indicated high plate counts, lumi-

nous bacteria, and presumptive *Vibrio* counts. Disease monitoring and analysis will persist in 2023 to enhance the culture of shortfin scad in captivity.

Sustainable aquaculture

Alternative feeds

To reduce the cost of feeds, especially for small-scale freshwater farmers, SEAFDEC/AQD aimed to replace or reduce the use of expensive conventional ingredients in feeds, such as fish meal, with alternative protein sources like aquatic weeds, invasive alien species, microbial biomass, and fish by-products in fish and prawn diets, thereby reducing feed costs.

Feeding trials using aquatic weeds, water hyacinth, and water cabbage as replacements for soybean meal in tilapia diets in a bio-floc-based system were continued. Two-stage fermentation processes were employed to enhance the nutritional value of aquatic weeds,



Black soldier fly larvae

and results indicated changes in ash, moisture, protein, and fat content due to fermentation.

The study explored the supplementation of insect meal as a substitute for fishmeal and soybean meal in tilapia diets in both biofloc-based and outdoor culture systems. Black soldier fly (BSF) larvae and adults were tested for their proximate composition, with larvae containing 36.35% crude protein and 42.68% crude lipid whereas the adult had 51.79% crude protein and 23.68% crude lipid. Feeding trials revealed that the inclusion of BSF larvae at 12% in the diet negatively impacted tilapia survival rates, although growth parameters were comparable.

The study extended to giant freshwater prawn (GFP) diets, testing BSF larvae and okara meals as alternative ingredients. Results indicated positive effects on the growth performance of GFP postlarvae in biofloc-based conditions when BSF larvae meal was included up to 25% on a protein basis. Outdoor cage trials further supported the positive impact of BSF-based diets on prawn growth and feed efficiency.

In 2023, the study plans to evaluate the performance of GFP postlarvae in tanks and lake-based cage conditions under feed restriction using the best-performing diet identified in previous trials.

Anguillid eel nutrition and health management

The study focuses on the feasibility of nursing Philippine native glass eels and elvers in captivity to address the high cost of feeds and potential pathogens during culture. Two independent nursery-rearing trials were conducted at SEAFDEC/AQD's Binangonan Freshwater Sta-



Live food and formulated eel diet used in nursery rearing trials

tion (BFS) and Tigbauan Main Station (TMS).

In BFS, the effects of different feeding regimes on glass eel (*Anguilla bicolor pacifica*) growth and survival were assessed. After 58 days, *Tubifex*-fed glass eels showed significantly higher growth, while survival rates were comparable among *Tubifex*-fed and egg custard-fed groups. Further improvements in egg custard formulations are suggested to enhance growth performance.

Another BFS experiment examined the impact of feeding stimulants on glass eels. After 47 days, there were no significant differences in growth and survival among glass eels fed diets with feeding stimulants. The trial will be extended to 90 days for a clearer understanding of feeding stimulant effects.

In TMS, the potential use of annelids as starter feeds for glass eels was investigated, along with their influence on bacterial loading. Treatments included *Marphysa*, *Tubifex*, and formulated eel diet combinations. Preliminary results at day 45 showed that *Tubifex*-fed groups had higher weight and length, with survival rates ranging from 98.75% to 100%. Total plate or bacterial count was generally high at day 21 in most treatment

groups. Glass eel samples with unusual stomach conditions were collected for further analysis.

Community-based aquaculture of giant freshwater prawn

The study focuses on developing community-based strategies for the mass production of giant freshwater prawn (GFP) postlarvae to supply grow-out operators in the Philippines. After social preparation and policy formulation in previous years, the study established a GFP hatchery and nursery in Barangay Pipindan, Binangonan, Rizal, with the newly-formed Pipindan Aquaculture Producers Association (PAPA) as primary stakeholders.

In 2022, a Memorandum of Agreement (MOA) was signed, creating a tri-party collaboration between PAPA, the local government unit of Barangay Pipindan, and SEAFDEC/AQD, supported by the Government of Japan-Trust Fund. A usufruct agreement for the land hosting the hatchery was also signed. PAPA members underwent capacity-building activities on GFP culture at a temporary hatchery set-up within the Binangonan Freshwater Station. They observed and assisted in hatchery and nurs-

ery activities, including breeding, incubation, and larval rearing.

PAPA members successfully sold GFP postlarvae to eight buyers from June to December 2022, generating Php 10,110 (approximately USD 185). Challenges included limited production due to member skill levels, delays in brackishwater availability, inconsistent quality, non-compliance with feeding protocols, and weather fluctuations. Two typhoons in September and October also affected production.

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

In less than a year of operation, survival rates varied widely, ranging from 0.3% to 26.7%, with notable larval collapse in the first two weeks.

To initiate the GFP value chain, a market-linking field trip connected PAPA members to potential growers in Calauan, Laguna. Five farmers expressed interest in growing GFP, attended training sessions, and prepared ponds for GFP culture. The study aims to continue sustaining postlarvae production, enhancing broodstock management, supporting community-based hatchery operations, family-based grow-out, and exploring trial ranching opportunities in Laguna Lake and its tributaries in 2023.



Pipindan Aquaculture Producers Association members with Dr. Sayaka Ito (orange shorts) at the nearly-completed giant freshwater prawn hatchery

TRAINING AND INFORMATION

ANNUAL REPORT 2022

Trainees from the Bureau of Fisheries and Aquatic Resources holding pompano broodstock during a training on marine fish hatchery operations



Training Program

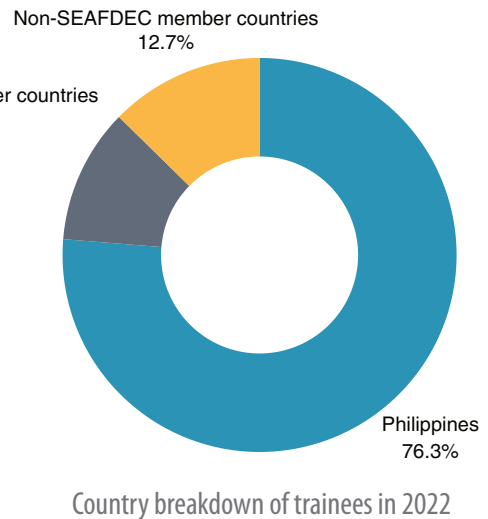
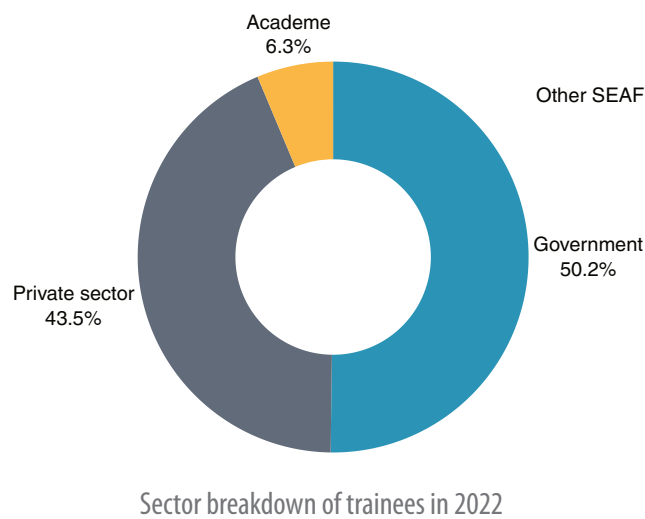
With the easing of COVID-19 restrictions, SEAFDEC/AQD has offered mostly in-person training courses in 2022 to provide the best learning experience to stakeholders. A total of 27 training courses were organized, only two of which were done virtually, while 25 were face-to-face. A total of 253 trainees

were catered through these courses, 50% percent of which came from the government sector, while 43% were from the private sector and the rest from the academe.

Most of the trainees (76%) came from the Philippines, a large portion of which were personnel from Philippine gov-

ernment agencies such are the National Fisheries Research and Development Institute (NFRDI).

SEAFDEC/AQD also accommodated 83 on-the-job trainees from 12 schools and universities in the Philippines, and 22 local and international interns.



Marine fish hatchery training course for the Office of the Provincial Agriculturist - Aklan



Fish health training course funded by the Government of Japan Trust Fund and National Fisheries Research and Development Institute

Course, date, venue	Total participants (Male/Female)	Countries represented by participants
Marine Fish Hatchery (Provincial Government of Aklan) 14–25 March 2022 (TMS, Tigbauan, Iloilo)	3 (2 M + 1 F)	Philippines
Mangrove Crab Hatchery & Nursery Operations (MSU Maguindanao) 19 April–3 May 2022 (TMS, Tigbauan, Iloilo)	5 (4 M + 1 F)	Philippines
Seaweed Culture (ISDABEST) 16–30 May 2022 (TMS, Tigbauan, Iloilo)	3 (3 F)	Philippines
Mangrove Crab Nursery & Grow-out Operations (AFOS Foundation) 16–25 May 2022 (TMS, Tigbauan, Iloilo)	5 (3 M + 2 F)	Philippines
Giant Freshwater Prawn Hatchery and Grow-out Operations 17–19 May 2022 (online)	12 (8 M + 4 F)	Malaysia, Pakistan, Philippines
Mangrove Crab Hatchery Operations (MAFAR-BARMM) 6–24 June 2022 (TMS, Tigbauan, Iloilo)	6 (4 M + 2 F)	Philippines
Natural Food Culture (Private) 13–21 June 2022 (TMS, Tigbauan, Iloilo)	1 (1 F)	Philippines
Marine Fish Hatchery (BFAR-IFAD) 20 June–25 July 2022 (TMS, Tigbauan, Iloilo)	10 (5 M + 5 F)	Philippines
Training-Workshop on Experimental Design & Analysis (RD/TID) 30 June–1 July 2022 (TMS, Tigbauan, Iloilo)	20 (8 M + 12 F)	Philippines
Milkfish Hatchery (Private) 4–15 July 2022 (TMS, Tigbauan, Iloilo)	2 (2 M)	Philippines
Aquaculture Technologies for Manpower Development 5 July–5 October 2022 (TMS, DBS, IMS)	4 (1 M + 3 F)	Philippines
Fish Health Management (GOJ-TF) 15–26 August 2022 (TMS, Tigbauan, Iloilo)	8 (4 M + 4 F)	Brunei Darussalam, Myanmar, Philippines, Viet Nam
Training Series on SEAFDEC/AQD-Developed Aquaculture Technologies for NFRDI Personnel Component 1: Fish Health Management (NFRDI) 15–26 August 2022 (TMS, Tigbauan, Iloilo)	7 (4 M + 3 F)	Philippines
Mangrove Crab Hatchery Operations 15 August–5 September 2022 (TMS, Tigbauan, Iloilo)	9 (7 M + 2 F)	Bangladesh, Philippines
Fish Nutrition and Feed Development (GOJ-TF) 29 August–2 September 2022 (TMS, Tigbauan, Iloilo)	8 (4 M + 4 F)	Brunei Darussalam, Myanmar, Philippines, Viet Nam
Training Series on SEAFDEC/AQD-Developed Aquaculture Technologies for NFRDI Personnel Component 2: Fish Nutrition and Feed Development (NFRDI) 29 August–2 September 2022 (TMS, Tigbauan, Iloilo)	7 (3 M + 4 F)	Philippines
Sandfish (<i>Holothuria scabra</i>) Culture (Mindoro State University) 30 August–4 September 2022 (TMS, Tigbauan, Iloilo)	10 (3 M + 7 F)	Philippines
Training Series on SEAFDEC/AQD-Developed Aquaculture Technologies for NFRDI Personnel Component 3: Natural Food Culture (NFRDI) 5–16 September 2022 (TMS, Tigbauan, Iloilo)	8 (4 M + 4 F)	Philippines
Milkfish Hatchery (Private) 19–23 September 2022 (TMS, Tigbauan, Iloilo)	1 (1 M)	Chile

Course, date, venue	Total participants (Male/Female)	Countries represented by participants
Training Series on SEAFDEC/AQD-Developed Aquaculture Technologies for NFRDI Personnel Component 4: Mangrove Crab Nursery & Grow-out Operations (NFRDI) 19–28 September 2022 (TMS, Tigbauan, Iloilo)	8 (4 M + 4 F)	Philippines
Mangrove Crab Nursery & Grow-out Operations 19–28 September 2022 (TMS, Tigbauan, Iloilo)	9 (4 M + 5 F)	Philippines
Training Series on SEAFDEC/AQD-Developed Aquaculture Technologies for NFRDI Personnel Component 5: Freshwater Aquaculture (NFRDI) 29 September–4 October 2022 (TMS, Tigbauan, Iloilo)	8 (4 M + 4 F)	Philippines
Sandfish (<i>Holothuria scabra</i>) Seed Production, Nursery and Grow-out 3–17 October 2022 (TMS, Tigbauan, Iloilo)	4 (3 M + 1 F)	Papua New Guinea
Training Series on SEAFDEC/AQD-Developed Aquaculture Technologies for NFRDI Personnel Component 6: Training-Workshop on Experimental Design and Analysis (NFRDI) 5–6 October 2022 (TMS, Tigbauan, Iloilo)	19 (7 M + 12 F)	Philippines
Community-Based Freshwater Aquaculture for Remote Rural Areas of Southeast Asia 7–21 November 2022 (Binangonan Freshwater Station)	5 (3 M + 2 F)	Malaysia, Philippines, Viet Nam
Mangrove Crab Nursery & Grow-out Operations (INFOFISH - Malaysia) 14–18 November 2022 (online)	39 (23 M + 16 F)	Bangladesh, Fiji, Malaysia, Papua New Guinea, Philippines, Sri Lanka, Thailand
Oyster Culture (DOST-Region VI) 22–23 November 2022 (Roxas City)	32 (16 M + 16 F)	Philippines



Training course on marine fish hatchery technologies for the Bureau of Fisheries and Aquatic Resources - Inland Fisheries Aquaculture Division



Special Internship Training Program on Seaweed Culture for a social enterprise that supports the livelihood of fishermen at project areas in Luzon

Science Papers in Journals and Proceedings

1. Apines-Amar, MJS*, Caipang, CMA*, Lopez, JDM*, Murillo, Ma. NA*, Amar, EC, Piñosa, LAG*, & Pedroso, FL* (2022). *Proteus mirabilis* (MJA 2.6S) from saline-tolerant tilapia exhibits potent antagonistic activity against *Vibrio* spp., enhances immunity, controls NH₃ levels and improves growth and survival in juvenile giant tiger shrimp, *Penaeus monodon*. *Aquaculture Research*, 53(16), 5510-5520. <https://doi.org/10.1111/are.16033>
2. Aya, FA, & Garcia, LMB* (2022). Cage culture of tropical eels, *Anguilla bicolor pacifica* and *A. marmorata* juveniles: Comparison of growth, feed utilization, biochemical composition and blood chemistry. *Aquaculture Research*, 53(17), 6283-6291. <https://doi.org/10.1111/are.16101>
3. Aya, FA, & Kudo, I* (2022). Effect of water mass mixing on phytoplankton dynamics in the scallop culture areas off Okhotsk Sea: A microcosm experiment. *Regional Studies in Marine Science*, 55, 102568. <https://doi.org/10.1016/j.rsma.2022.102568>
4. Aya, FA, & Kudo, I* (2022). Seasonal growth, organ indices and food consumption of the Japanese scallop *Patinopecten yessoensis* (Jay, 1857) in relation to food availability in Tokoro seabed, Okhotsk Sea, North Japan. *Plankton & Benthos Research*, 17(2), 156-164. <https://doi.org/10.3800/pbr.17.156>
5. Aya, FA, Moniruzzaman, M*, Pagador, GE, Won, S*, Hamidoghli, A*, Min, T*, & Bai, SC* (2022). Evaluation of dietary fermented tuna by-product meal as partial replacement for unprocessed tuna by-product meal in fishmeal-based diets for juvenile olive flounder *Paralichthys olivaceus*. *Fish Physiology and Biochemistry*, 48(6), 1507-1519. <https://doi.org/10.1007/s10695-022-01141-w>
6. Aya, FA, Sayco, MJP*, & Garcia, LMB* (2022). Effects of exogenous hormones and broodstock age on the spawning response of captive silver therapon *Leiopotherapon plumbeus*. *Journal of Applied Ichthyology*, 38(2), 232-240. <https://doi.org/10.1111/jai.14297>
7. Caipang, CMA*, Deocampo, Jr., JE*, Pakingking, Jr., RV, Fenol, JT*, & Onayan, FB* (2022). Rapid screening of potential probiotics from the gut microbiota of climbing perch, *Anabas testudineus*. *Journal of Biodiversity and Environmental Sciences*, 21(3), 82-88.
8. Caipang, CMA*, Trebol, KMP*, Abeto, MJS*, Coloso, RM*, Pakingking, Jr., RV, Calpe, AT*, & Deocampo Jr., JE* (2022). An innovative biofloc technology for the nursery production of Pacific whiteleg shrimp, *Penaeus vannamei* in tanks. *International Journal of Biosciences*, 21(4), 71-79. <https://doi.org/10.12692/ijb/21.4.71-79>
9. Caipang, C. M. A.*, Trebol, K. M. P.*, Abeto, M. J. S.*, Coloso, R. M.*, Pakingking, Jr., R. V., Calpe, A. T., & Deocampo, Jr., J. E.* (2022). Innofloc: Innovative biofloc technology for the nursery production of shrimp, *Litopenaeus vannamei* in tanks. In A. J. G. Ferrer (Ed.), *Proceeding of Joint International Conference of the Sixth International Conference on Fisheries and Aquatic Sciences (ICFAS 6) and Asian Fisheries Social Science Research Network Forum One (AFSSRN F1)*, 24-26 November 2021, via Zoom, Miagao, Iloilo, Philippines (pp. 241-245). University of the Philippines Visayas.
10. Caipang, CMA*, Trebol, MP*, Fagutao, FF*, Pakingking, RV, & Jr. Deocampo, JE*, Jr. (2022). Biofloc-based nursery production system: heeding the call towards a sustainable shrimp culture industry in the Philippines. *International Journal of Biosciences*, 20(3), 250-259.
11. de la Cruz-Huervana, JJ, Dionela, C*, & Franco, A (2022). Use of rotifers-fed microalgal paste in the seed production of mangrove crab *Scylla serrata* in the Philippines. *Journal of Applied Phycology*, 34, 3047-3057. <https://doi.org/10.1007/s10811-022-02841-9>
12. Erazo-Pagador, G, Dumaran-Paciente, HR*, & Caloyloy, BJ* (2022). Acute lethal toxicity of dried garlic (*Allium sativum*) powder on orange-spotted grouper (*Epinephelus coioides*) juveniles under static exposure. *Bulletin of the European Association of Fish Pathologists*, 42(1), 28-38. <https://doi.org/10.48045/001c.38092>
13. Ito, S, Onitsuka, T*, Kuroda, H*, Hasegawa, N*, Fukuda, H*, Gouda, H*, Akino, H*, Sonoki, S*, Endo, K*, Takayama, T*, Nagase, K*, & Shirafuji, N* (2022). Evaluation of seafloor environmental characteristics of harvesting ground of a kelp *Saccharina longissima* using GIS in the Pacific coastal area of eastern Hokkaido, Japan. *Regional Studies in Marine Science*, 55, 102527. <https://doi.org/10.1016/j.rsma.2022.102527>
14. Ito, S, Tamura, Y*, Sato, A*, Onishi, H*, Shibuya, M*, Uchida, Y*, Inoue, M*, & Omori, K* (2021). Effect of a non-native freshwater goby invasion on spawning habitat use of two native freshwater gobies. *Environmental Biology of Fishes*, 104(10), 1341-1351. <https://doi.org/10.1007/s10641-021-01159-8>
15. Ito, S, Tamura, Y*, Sato, A*, Onishi, H*, Shibuya, M*, Uchida, Y*, Inoue, M*, & Omori, K* (2021). Occurrence and disappearance of a non-native goby *Rhinogobius* sp. OR in relation to hydrological conditions in the Kamo River, southwestern Japan. *Ichthyological Research*, 69(1), 176-181. <https://doi.org/10.1007/s10228-021-00819-0>
16. Kounthongbang, A*, Souliyamath, P*, Chanthasone, P*, Phommachan, P*, Lasasimma, O*, Okutsu, TI, & Ito, S (2021). Daytime habitat use and abundance of a freshwater shrimp *Macrobrachium yui* Holthuis, 1950 (Decapoda: Palaemonidae) in tropical forest stream, northern Laos. *Crustacean*

- Research, 50, 151-163. https://doi.org/10.18353/crustacea.50.0_151
17. Leбата-Ramos, MJHL, Dionela, CS*, Solis, EFD, Mediavilla, JP*, Sibonga, RC*, & Novilla, SRM* (2022). Settlement of oyster *Magallana bilineata* (Röding, 1798) spat in the natural environment: seasonality and substrate texture preference. *Molluscan Research*, 42(2), 135-145. <https://doi.org/10.1080/13235818.2022.2073651>
 18. Logronio, DJC*, Somga, JR*, Romana-Eguia, MRR, Somga, S*, Catedral, D, & Coloma, G, Jr. (2022). Phylogenetic analysis of tilapia lake virus (TiLV) isolates from the Philippines based on partial genome segment 3 sequences. *Philippine Agricultural Scientist*, 105(1), 100-106. (Short communication)
 19. Luhan, MRJ*, Mateo, JP*, & Sollesta-Pitogo, H (2022). Growth and carrageenan quality of sporophyte and gametophyte of the commercially important red seaweed *Kappaphycus alvarezii*. *Philippine Journal of Science*, 151 (S1): 129-134.
 20. Lumayno, SDP*, Benico, G*, Yñiguez, A*, Alabia, ID*, Fernandez, IQD*, Dianala, RDB, Azanza, R*, & Villanoy, C* (2022). Residence time models and *Pyrodinium* blooms in Matarinao and Murcielagos Bays, Philippines. *Philippine Journal of Science*, 151(S1), 79-90.
 21. Monghit-Camarin, M*, Cruz-Lacierda, E*, Pakingking, Jr., RV, Cuvin-Aralar, ML*, Traifalgar, RFM*, Añasco, NC*, Austin, FW*, & Lawrence, ML*(2022). Bacterial microbiota of hatchery-reared freshwater prawn *Macrobrachium rosenbergii* (De Man, 1879) and their pathogenicity. In A. J. G. Ferrer (Ed.), *Proceeding of Joint International Conference of the Sixth International Conference on Fisheries and Aquatic Sciences (ICFAS 6) and Asian Fisheries Social Science Research Network Forum One (AFSSRN F1)*, 24-26 November 2021, via Zoom, Miagao, Iloilo, Philippines (pp. 209–215). University of the Philippines Visayas.
 22. Nocillado, J*, Palma, P*, Wang, T*, de Jesus-Ayson, EGT*, Levavi-Sivan, B*, & Elizur, A* (2022). Intracellular production of recombinant GnRH1 in yeast, *Pichia pastoris*, and its potential as oral treatment to advance gonadal development in juvenile orange-spotted grouper, *Epinephelus coioides*. *Aquaculture*, 554, 738115. <https://doi.org/10.1016/j.aquaculture.2022.738115>
 23. Pakingking, R, Espanola, JG*, Palma, P*, & Usero, R* (2022). Motile aeromonads recovered from tilapia (*Oreochromis niloticus*) cultured in earthen ponds in the Philippines: Assessment of antibiotic susceptibility and multidrug resistance to selected antibiotics. *Israeli Journal of Aquaculture - Bamidgeh*, 74, 1-11. <https://doi.org/10.46989/001c.37010>
 24. Pakingking, Jr., R, Palma, P*, de Jesus-Ayson, EG*, & Usero, R* (2022). *Vibrio* load and percentage composition of sucrose-fermenting vibrios in Nile tilapia (*Oreochromis niloticus*) cultured in brackish water earthen ponds and biocontrol potential of recycled tilapia-conditioned greenwater against population growth of *V. parahaemolyticus* and non-sucrose-fermenting vibrios in the grow-out culture of white leg shrimp (*Litopenaeus vannamei*). *Aquaculture Research*, 53(18), 6816-683. <https://doi.org/10.1111/are.16148>
 25. Pakingking Jr., R, Usero, R*, de Jesus-Ayson, EG*, Logronio, DJ*, & Caipang, CM* (2022). Phytochemical composition antioxidant and antibacterial activity of the Philippine marine green alga (*Ulva pertusa*). *International Aquatic Research*, 14(1), 51-62. <https://doi.org/10.22034/IAR.2022.1946410.1217>
 26. Palma, P*, Beluso, LA*, de Jesus-Ayson, EG*, & Cruz-Lacierda, ER* (2022). Seasonal population dynamics of *Lepeophtheirus spinifer* and *Neobenedenia* sp. coinfecting snubnose pompano (*Trachinotus blochii*) breeders in marine cages in the Philippines. *Veterinary Parasitology*, 302, 109656. <https://doi.org/10.1016/j.vetpar.2022.109656>
 27. Romana-Eguia, MRR, Samoranos, MN*, Aya, F, Alava, VR*, & Salayo, ND (2022). A technical and economic evaluation of supplemental feeding strategies for Nile tilapia (*Oreochromis niloticus* L.) reared in lake-based cages. *Israeli Journal of Aquaculture - Bamidgeh*, 74 (March), 1-11.1687894. <https://doi.org/10.46989/001c.33604>
 28. Salayo, ND, Castel, RJG, Montinola, QS, Diamante, RA, & Kodama, M* (2022). Evaluation of community-based livelihood development initiatives: The sustainable livelihood approach. In AJG Ferrer (Ed.), *Proceeding of Joint International Conference of the Sixth International Conference on Fisheries and Aquatic Sciences (ICFAS 6) and Asian Fisheries Social Science Research Network Forum One (AFSSRN F1)*, 24-26 November 2021, via Zoom, Miagao, Iloilo, Philippines (pp. 473–480). University of the Philippines Visayas.
 29. Santander-Avanceña, S, Monteclaro, H*, Estante-Superio, E, Catedral, DD, & Traifalgar, RF* (2022). The influence of monosex rearing on gonad maturation and reproductive behavior of Indian white prawn, *Penaeus indicus* broodstock. *Aquaculture*, 522, 738030. <https://doi.org/10.1016/j.aquaculture.2022.738030>
 30. Santander-Avanceña, SS, Traifalgar, RFM*, Monteclaro, HM*, Castellano, JLA, Cordero, CP, Laureta, LV*, & Quintino, GF* (2022). Evaluation of maturation promoting factor in polychaete

This list is compiled based on the 2022 author reports to the SEAFDEC/AQD Databank. Publications dated 2023 were electronically available in 2022 and published in a journal issue in 2023. Askterisks (*) indicate non-SEAFDEC authors or SEAFDEC personnel who have retired or separated from service prior to the publication date.

(*Marphysa* sp.) on Indian white prawn, *Penaeus indicus* female broodstock. *Aquaculture Research*. 53(15): 5195-5204. <https://doi.org/10.1111/are.16003>

31. Sibonga, RC*, Brakel, J*, Gachon, CMM*, Faisan, Jr., JP, Brodie, J*, Ward, G*, Ferriols, VMEN*, Luhan, MRJ*, & Hurtado, AQ* (2022). Characterization of wild eucheumatoids from Visayas, Philippines as inferred from the mitochondrial cox2-3 spacer sequence. In A. J. G. Ferrer (Ed.), *Proceeding of Joint International Conference of the Sixth International Conference on Fisheries and Aquatic Sciences (ICFAS 6) and Asian Fisheries Social Science Research Network Forum One (AFSSRN F1)*, 24-26 November 2021, via Zoom, Miagao, Iloilo, Philippines (pp. 82–88). University of the Philippines Visayas.
32. Sibonga, RC*, Laureta, LV*, Lebata-Ramos, MJH, Nievaes, MFJ*, &

Pedroso, FL* (2022). Comparison of commercial *Spirulina*, live *Navicula* sp. and *Chaetoceros calcitrans* concentrate as settlement cues for sandfish, *Holothuria scabra*. *Journal of Applied Phycology*, 34, 2099-2105. <https://doi.org/10.1007/s10811-022-02767-2>

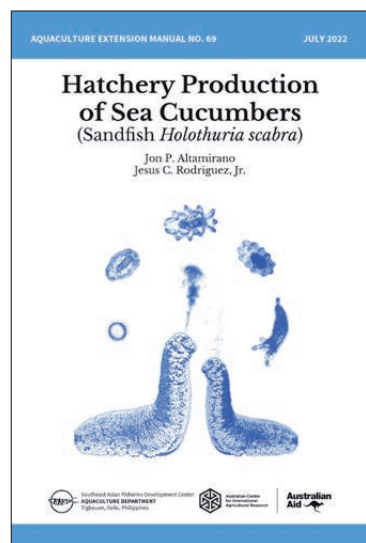
33. Tendencia, EA (2022). Accumulation and Depletion of Oxytetracycline (OTC) and Oxolinic Acid (OXA) in Pompano, *Trachinotus blochii*. *Bulletin of the European Association of Fish Pathologists*, 42(1), 1-14. <https://doi.org/10.48045/001c.37646>
34. Thien, FY*, Hamasaki, K*, Shapawi, R*, Kawamura, G*, de la Cruz-Huervana, JJ, & Yong, ASK* (2022). Effect of background tank color in combination with sand substrate and shelters on survival and growth of *Scylla tranquebarica* instar. *The Egyptian Journal of Aquatic Research*, 48(3), 241-246. <https://doi.org/10.1016/j.ejar.2022.04.004>

35. Villa-Franco, AU, dela Peña, MR, & Nievaes, MFJ* (2022). Grazing periodicity, grazing rate, feeding preference, and gut examination of early juveniles of abalone *Haliotis asinina*-fed five benthic diatom species. *Aquaculture International*. 30, 2343-2364.

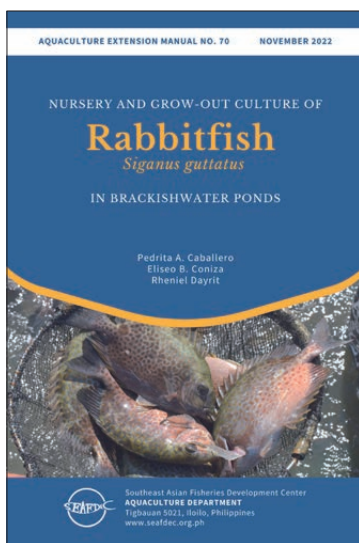
36. Villa-Franco, AU, Teves, CML*, Dato-on, KLG*, Ayson, EGDJ*, Usero, RC*, & de la Peña, MR* (2022). Production, feeding and storage of *Tetraselmis tetraethele* paste by electrolytic flocculation. *Journal of Applied Phycology*. <https://doi.org/10.1007/s10811-022-02887-9>
37. Ward, GM*, Kambey, CS*, Faisan Jr, JP, Tan, PL*, Daumich, CC, Matoju, I*, ... & Poong, SW* (2022). Ice-Ice disease: An environmentally and microbiologically driven syndrome in tropical seaweed aquaculture. *Reviews in Aquaculture*, 14(1), 414-439. <https://doi.org/10.1111/raq.12606>

Other Publications

Extension manuals

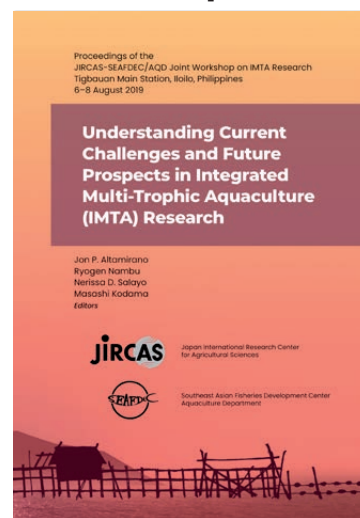


Hatchery Production of Sea Cucumbers (Sandfish *Holothuria scabra*) (Aquaculture Extension Manual No. 69)



Nursery and Grow-out Culture of Rabbitfish *Siganus guttatus* in Brackishwater Ponds (AEM No. 70)

Conference proceedings



Understanding Current Challenges and Future Prospects in Integrated Multi-Trophic Aquaculture (IMTA) Research

AQD Matters newsletter issues



January–February 2022 issue



March–April 2022 issue



May–June 2022 issue



July–August 2022 issue



September–October 2022 issue



November–December 2022 issue

Status of distribution of publications as of 31 December 2022

Type and title of publication	Prints produced	Prints distributed	Downloads through repository*
Extension manual: Hatchery Production of Sea Cucumbers (<i>Sandfish <i>Holothuria scabra</i></i>)	800	206	2,078
Extension manual: Nursery and Grow-out Culture of Rabbitfish <i>Siganus guttatus</i> in Brackishwater Ponds	**	-	484
Proceedings: Understanding Current Challenges and Future Prospects in Integrated Multi-Trophic Aquaculture (IMTA) Research	200	193	255
Newsletter: AQD Matters (aggregate of all issues)	505	505	2,028

*publications with download data are freely downloadable online through the SEAFDEC/AQD Institutional Repository

**printed in 2023

Online Platforms

Website
www.seafdec.org.ph

60K
(+11K ▲ 22%)

2022 UNIQUE USERS
Top-visited webpages were "Farming Mangrove Crab," "Farming Giant Freshwater Prawn," and "Training Schedule"

Institutional Repository
repository.seafdec.org.ph

429K*
(+40K ▲ 10%)

2022 DOWNLOADS
*Reported statistic excludes downloads by bots and crawlers

Social Media
fb.com/seafdec.aqd
fb.com/seafdecaqdlb
fb.com/fishworld

37K
(+6K ▲ 18%)

FACEBOOK FOLLOWERS
Combined followers of Facebook pages (including Library, FishWorld)

News and Media

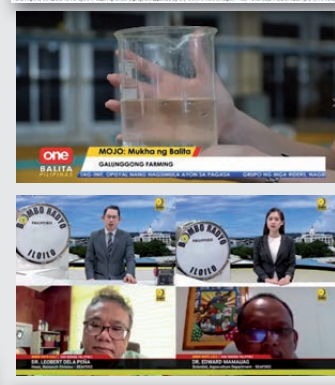
37*
NEWSPAPER, MAGAZINE PRINT EXPOSURES

73*
ONLINE NEWS EXPOSURES

3
RADIO GUESTINGS

1
TELEVISION FEATURE

*minimum approximate values due to reporting limitations



Exhibitions



Davao Agri-Trade Expo 2022 (Davao City, 29–30 Sept. 2022)



AgriLink 2022 (Pasay City, 6–8 Oct. 2022)



Forty-fifth SEAFDEC Program Committee Meeting commodity exhibit (Tigbauan, Iloilo, 6–7 Dec. 2022)



FishWorld

FishWorld, the museum and visitor center of SEAFDEC/AQD, started accepting visitors in January 2022 after the relaxing of pandemic restrictions. Around 1,600 visitors were logged for the year.

This year, the FishWorld assisted in the release of an olive ridley sea turtle in Barotac Viejo, Iloilo after nine months of rehabilitation. Staff also assisted in the immediate release of a stranded juvenile green sea turtle at Tigbauan, Iloilo. Staff also participated in seminars to impart knowledge on how to properly handle and aid stranded, captured, and turned-over marine turtles through seminars.

The museum also hosted five high school interns for 10 days.



FishWorld personnel conducted a necropsy of a sea cow ("dugong") along with staff from the National Museum Western Visayas

Activities included taxidermy, sea turtle identification, coastal clean-up, and assist in tilapia sampling.

A memorandum of agreement which clarified the role of SEAFDEC/AQD in managing stranded,

captured, and turned-over marine turtles was signed this year with the Department of Environment and Natural Resources – Region 6.

PRODUCTION AND SERVICES

ANNUAL REPORT 2022



Pompano harvested at the Igang Marine Station

Hatchery and grow-out production

Seedstock and market-size commodities are produced at SEAFDEC/AQD facilities to supply the needs of research projects, fish farmers, and for verification purposes.

Milkfish continues to be the top seedstock with 6.6 million fry produced in 2022. Over 5.8 million of these were sold to private fish farms while the rest were used for research. Milkfish is followed by bighead carp (*Aristichthys nobilis*) wherein 1 million fry were produced during a freshwater training course held at the Binangonan Freshwater Station. The black tiger shrimp also continued to be the top-produced crustacean with 877,000 postlarvae grown. The production of giant freshwater prawn has more than quadrupled to 206,101 in 2022 from just 44,600 in 2021. Production of sandfish early juveniles also increased by 2.5 times, to 280,029 from just 111,466 in 2021.

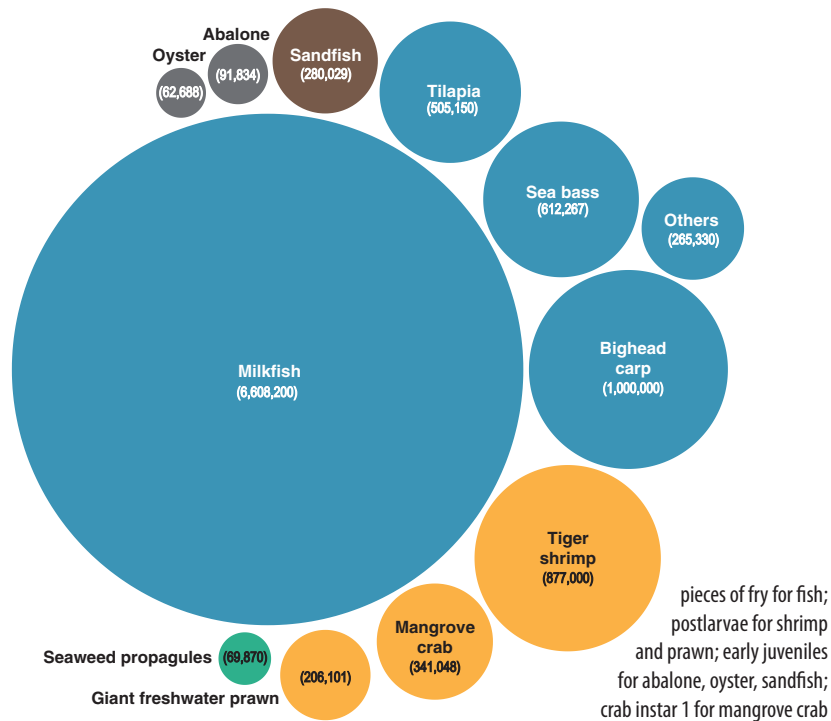
Pompano was the top-produced market-size commodity with 22.6 metric tons produced this year. Milkfish production fell behind with 12.7 metric tons, followed by whiteleg shrimp at 7.2 metric tons.

For seaweeds, 69,870 propagules were produced through tissue culture. From these, 22,593 plantlets were produced of which 7,050 were given to seaweed farmers and the academe.

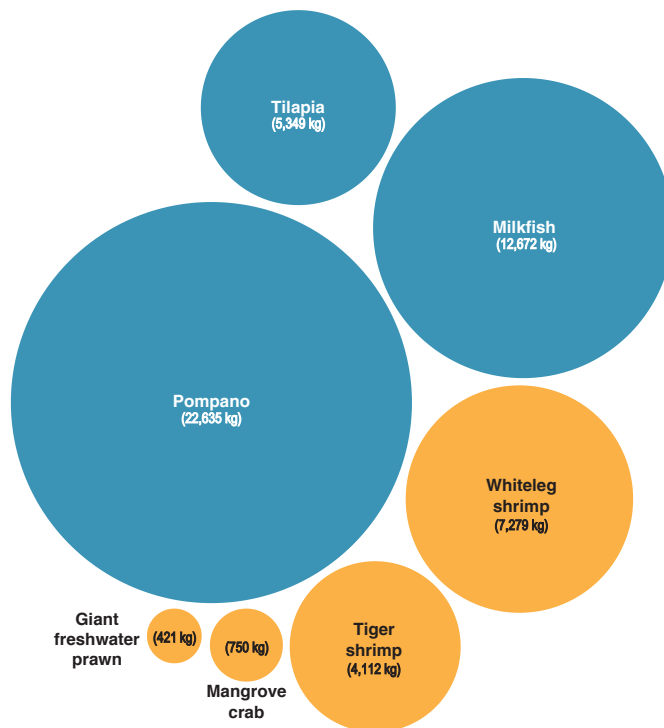
10.9M
PIECES OF VARIOUS
SEEDSTOCK PRODUCED

53
TONS OF MARKET-SIZE
COMMODITIES HARVESTED

Seedstock produced and harvested in 2022



Market-size commodities harvested in 2022



Larval food production

To support the research and production activities of SEAFDEC/AQD, the larval food laboratories at the Tigbauan Main Station and Binangonan Freshwater Station produced 14,065 liters of liquid algal and zooplankton starters, and 20.23 kilograms (paste) of microalgal and rotifer starters in 2022. Bulk of the liquid microalgal starters produced, around 13,044 liters, was used for SEAFDEC/AQD's research projects and the rest was sold to the institution's clients.

Feed mill production

In 2022, the Feed Mill produced more than 61 tons of aquafeeds and ingredients for various commodities. Of these, 55 tons were produced for SEAFDEC/AQD's research projects. A total of about 6.56 tons were produced by Feed Mill for external clients from the private sector and the academe. Most of the feeds (42%) were milkfish diets, followed by tilapia diets (24%) and diets for high-value fish (24%).

61 TONS OF VARIOUS AQUAFEEDS PRODUCED

Microalgal starters produced in 2022

Type of liquid microalgae starter	Liters produced
Binangonan Freshwater Station	
<i>Chlorella vulgaris</i>	7
<i>Chlorella sorokiniana</i>	20
<i>Spirulina platensis</i>	10
Tigbauan Main Station	
<i>Amphora</i> sp.	1.6
<i>Chaetoceros calcitrans</i>	2, 279
<i>Chaetoceros muelleri</i>	223
<i>Chaetoceros</i> sp.	4
<i>Chlorella sorokiniana</i> (15 ppt)	73
<i>Chlorella sorokiniana</i> (0 ppt)	133
<i>Isochrysis galbana</i>	1,890
<i>Nannochloropsis</i>	10
<i>Nannochlorum</i> sp.	1,630
<i>Navicula ramossissima</i>	3,372
<i>Nitzschia</i> sp.	120
<i>Skeletonema tropicum</i>	445
<i>Tetraselmis tetrahele</i>	3,488
<i>Thalassiosira</i> sp.	229
<i>Thalassiosira</i> sp. (code SIS)	1
<i>Thalassiosira weisflogii</i>	1
Total	13,938

14,065
LITERS OF LARVAL FOOD STARTERS PRODUCED

Zooplankton starters produced in 2022

Type of zooplankton starter	Quantity produced
Binangonan Freshwater Station	
<i>Brachionus rotundiformis</i>	25 L
Tigbauan Main Station	
<i>Artemia salina</i>	97 g
<i>Brachionus rotundiformis</i>	98 L
<i>Proales similis</i>	4 L
Total	13,938

Microalgal paste produced

Type of algal paste	Grams produced
<i>Chaetoceros calcitrans</i>	3,500
<i>Chlorella sorokiniana</i> (15 ppt)	12,030
<i>Nannochlorum</i> sp.	2,100
<i>Nannochlorum</i> sp. - tilapia	600
<i>Tetraselmis tetrahele</i>	2,000
Total	20,230

SEAFDEC/AQD Feed Mill production in 2022

Type of aquafeed	For SEAFDEC	For stakeholders	Total feeds produced
Abalone	0.03		0.03
Silver Therapon	0.07		0.07
Catfish		0.05	0.05
Eel	0.04		0.04
High-value Fishes	14.55	0.04	14.59
Milkfish	20.34	5.70	26.07
Mangrove crab	0.16		0.16
Pompano	0.10		0.10
Shrimp	0.85		0.85
Siganid	0.30		0.30
Tilapia	18.68	0.17	18.85
Ingredients	0.36	0.12	0.48
Total			61.56

Analytical Services

The Centralized Analytical Laboratory (CAL) under the Laboratory Facilities for Advanced Aquaculture Technologies (LFAAT) accepted 1,091 samples in 2022, most of which were analyzed in support of SEAFDEC/AQD's various research programs. Other samples were submitted by stakeholders from the private sector, the academe, and government agencies. Of these samples, a total of 2,327 determinations were conducted by the laboratory. LFAAT also received 13 requests on the use of laboratory facilities.

The laboratory's select biological and chemical testing services continued to be accredited by the Philippine Accreditation Bureau based on the standards set by the ISO/IEC 17025:2017. Accredited laboratory services include water analyses such as total coliform count, fecal coliform count, pH level, ammonia-nitrogen, nitrite-nitrogen, and phosphate-phosphorus. Also included in the accreditation is the chemical testing of agricultural products and materials for moisture, ash, and crude protein analyses.

Diagnostic Services

The Fish Health Section handles diagnostic cases for a range of viruses, bacteria and parasites. Diagnostic services analyzed 3,929 samples in 2022, most of which were shrimp and water samples.

Pathogens were detected mainly through polymerase chain reaction (PCR) with 2,231 samples analyzed. Acute hepatopancreatic necrosis disease (AHPND) was the

2,327

ANALYTICAL DETERMINATIONS

3,929

SAMPLES EXAMINED FOR DIAGNOSTIC CASES

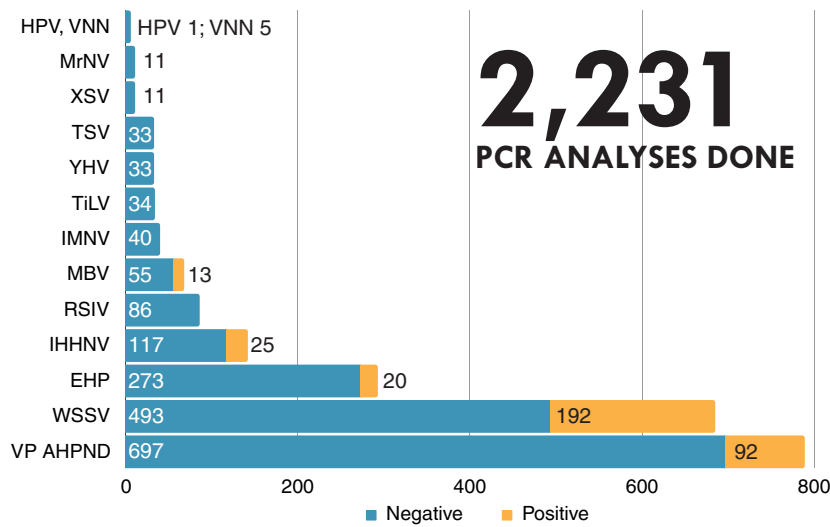
Types of laboratory analyses conducted and determinations made in 2022

Type of liquid microalgae starter	Samples analyzed	Number of determinations
Proximate Analyses	358	1,467
Water Analyses	617	2,079
Soil Analyses	44	161
Microbiological Analyses	39	51
Electron Microscopy	28	28
Fatty Acid Profiling	2	2
Metal Analyses	3	6

Diagnostic cases examined

Type of sample	Samples analyzed
Algal paste (<i>Nannochloropsis</i> sp.)	3
Annelids (<i>Tubifex</i> sp.)	17
Bacterial colonies (for AHPND analysis)	220
Bacterial identification	230
Bacterial isolates	23
Blood cockle (<i>Tegillarca granosa</i>)	103
<i>Brachionus</i>	1
Brine shrimp (<i>Artemia</i>)	9
Brown-marbled grouper (<i>Epinephelus fuscoguttatus</i>)	2
Climbing perch (<i>Anabas testudineus</i>)	45
Mangrove crab (<i>Scylla</i> spp.)	12
Eel	3
Feeds	2
Freshwater prawn (<i>Macrobrachium rosenbergii</i>)	12
Mangrove crab (<i>Scylla serrata</i>)	98
Seaweed (<i>Gracilaria</i>)	39
Grouper (<i>Epinephelus</i> spp.)	22
Indian white prawn (<i>Penaeus indicus</i>)	28
Milkfish (<i>Chanos chanos</i>)	39

Type of sample	Samples analyzed
Oyster (<i>Crassostrea</i> sp.)	2
Polychaete (<i>Marphysa</i> sp.)	36
Pompano (<i>Trachinotus blochii</i>)	94
Probiotic	7
Red tail scad (<i>Decapterus kurroides</i>)	8
Sandfish (<i>Holothuria scabra</i>)	1
Seaweeds	48
Shortfin scad (<i>Decapterus macrosoma</i>)	8
Siganid (<i>Siganus guttatus</i>)	13
Silver therapon (<i>Leiopotherapon plumbeus</i>)	137
Slipper lobster (<i>Thenus orientalis</i>)	59
Snapper (<i>Lutjanus</i> sp.)	1
Soil	73
Tiger shrimp (<i>Penaeus monodon</i>)	298
Tilapia (<i>Oreochromis</i> sp.)	131
Tuna (<i>Euthynnus affinis</i>)	219
Water	1012
Whiteleg shrimp (<i>Penaeus vannamei</i>)	807
Yellow tail scad	67



Diagnostic cases examined

- HPV Hepatopancreatic Parvovirus
- VNN Viral Nervous Necrosis (Betanodavirus)
- MrNV *Macrobrachium rosenbergii* nodavirus
- XSV Extra Small Virus
- TSV Taura Syndrome Virus
- YHV Yellow Head Virus
- TiLV Tilapia Lake Virus
- IMNV Infectious Myonecrosis Virus
- MBV Monodon Baculovirus
- RSIV Red Sea Bream Iridovirus
- IHHNV Infectious Hypodermal and Haematopoietic Necrosis Virus
- EHP *Enterocytozoon hepatopenaei*
- WSSV White Spot Syndrome Virus
- VP_{AHPND} *Vibrio parahaemolyticus* (Acute hepatopancreatic necrosis disease)

Histological slide preparation

Type of liquid microalgae starter	Samples analyzed	Number of determinations
Blood cockle (<i>Tegillarca granosa</i>)	103	103
Brown-marbled grouper (<i>Epinephelus fuscoguttatus</i>)	2	2
Climbing perch (<i>Anabas testudineus</i>)	45	45
Eel	3	7
Milkfish (<i>Chanos chanos</i>)	30	30
Orange-spotted grouper (<i>Epinephelus coioides</i>)	2	2
Pompano (<i>Trachinotus blochii</i>)	77	83
Sandfish (<i>Holothuria scabra</i>)	1	1
Silver therapon (<i>Leiopotherapon plumbeus</i>)	77	20
Tiger prawn (<i>Penaeus monodon</i>)	44	44
Tilapia (<i>Oreochromis niloticus</i>)	127	185
Tuna (<i>Euthynnus affinis</i>)	210	135
Whiteleg shrimp (<i>Penaeus vannamei</i>)	95	124
Yellow tail scad (<i>Decapterus macrosoma</i>)	59	59
Total	875	840

840

SLIDES PREPARED
FROM 875 SAMPLES

most requested disease for diagnosis with 789 samples analyzed followed by white spot syndrome with 685 samples.

Other analyses were done such as bacterial identification which processed 230 isolates. Fry quality evaluation was also done on 83 whiteleg shrimp and 11 tiger shrimp PCR-positive samples. Parasite detection and identification was also done for grouper, shortfin scad, tilapia, and siganids.

Meanwhile, the Microtechnique Laboratory released 840 slides from 875 samples received.

Library services

The present collection of the SEAFDEC/AQD Library stands at 47,505 titles with 82,185 volumes or copies. The collections stand at 21,615 monographs, 5,944 SEAFDEC Publications, 20,998 bound serial volumes, 10,774 pamphlets, and a variety of maps, posters, microfiche, and CD-ROMs. These were available for use and could be searched online through the SEAFDEC/AQD Library Online Public Access Catalog (OPAC). OPAC was visited by a total of 4,395 global searchers.

47,505
TITLES IN THE LIBRARY
COLLECTION

82,185
VOLUMES/COPIES IN THE
LIBRARY COLLECTION

4,395
ONLINE PUBLIC ACCESS
CATALOG SEARCHERS

2,376
DOCUMENT REQUESTS
FROM 1,580 INDIVIDUALS

The Library continuously provides bibliographic records (indexing and abstracting) to Aquatic Sciences and Fisheries Abstracts (ASFA), Elsevier Science Direct, Springer, ProQuest Central, Emerald Insight, University of Chicago Press, Edinburgh University Press Journals Online, Geological Society - The Lyell Collection Complete, British Institute of Radiology Journals and Liebert Online, and The Essential Electronic Agricultural Library (TEEAL).

A total of 2,376 (2,096 SAIR; 280 in-house) document requests were received from about 1,580 (1,536 SAIR; 44 in-house) individuals. Eighty-six percent of the documents

requested were placed thru the SEAFDEC/AQD Institutional Repository (SAIR). The majority of the requesters were from the Philippines, India, Malaysia, Indonesia, USA, Malawi, Thailand, United Kingdom, Bangladesh, and Belgium. The remaining percentage of documents requested were in person, and remotely, through email, phone, chat, and Facebook messenger, the majority by SEAFDEC/AQD employees.

HUMAN RESOURCES AND FINANCE

ANNUAL REPORT 2022

SEAFDEC/AQD employees during the 2022
Christmas Program at the Muti-Purpose Hall



Personnel distribution

As of end of 2022, SEAFDEC/AQD's personnel numbered 306 composed of 78 regular employees, 90 fixed-term staff, 117 casuals, and 21 contractors/consultants.

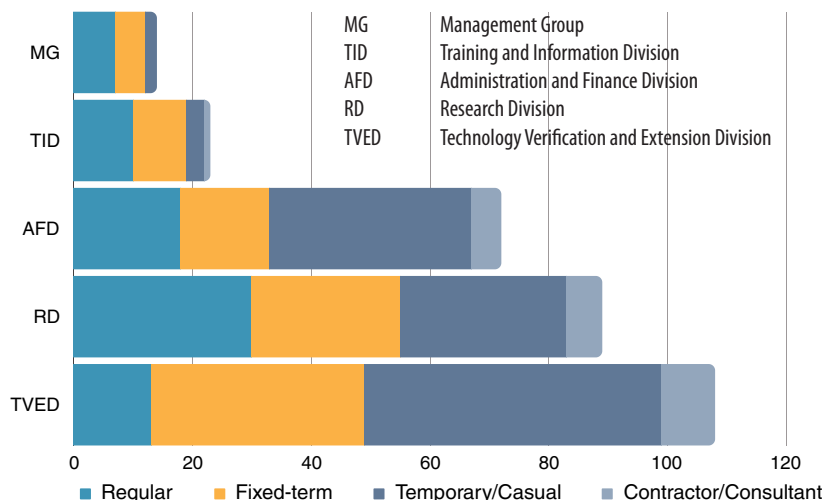
The Technology Verification and Extension Division (TVED) had the most staff (108) assigned to it, followed by the Research Division (RD) with 89, Administration and Finance Division (AFD) with 72, and the Training and Information Division (TID) with 23. The Management Group was composed of 14 personnel.

This year, two junior staff were upgraded to a senior position, one from the Research Division and another from the Training and Information Division.

Among regular and fixed-term personnel of the Research Division, 16% (9) have doctorates, 22% (12) have masters degrees, and 55% (30) have bachelor's degrees.

Staff development

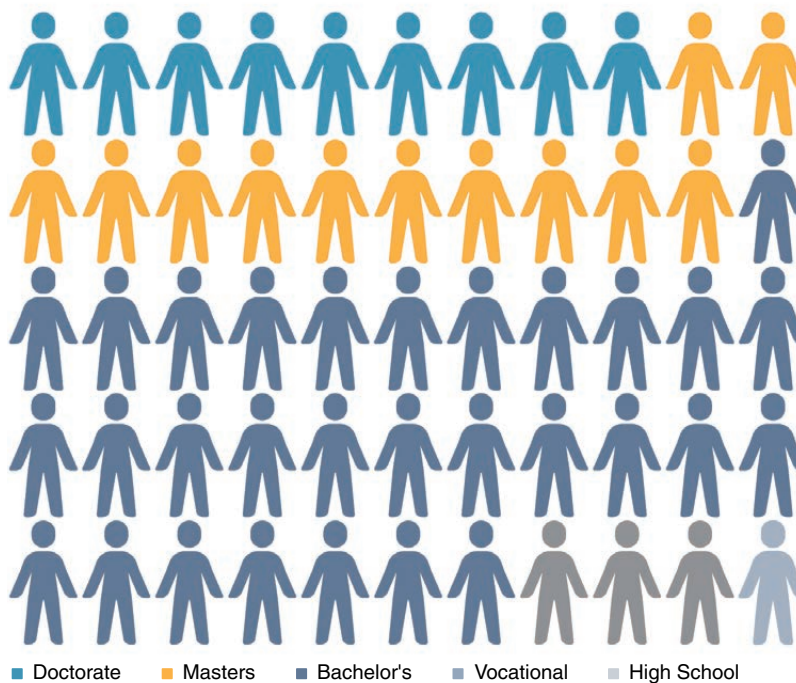
To enhance and upgrade the knowledge and skills of its employees, SEAFDEC/AQD supports for the attendance and participation of staff in local and international meetings and conferences through the Staff Development Program. This year, two personnel attended the 77th Philippine Institute of Certified Public Accountants (PIC-PA) Annual National Convention in Cebu City. Another attended the World Conference on Agriculture, Food, and Nutrition in Valencia, Spain. A research staff also received a study leave with pay for her Japanese Government Scholarship based in Nagasaki, Japan.



Personnel distribution across divisions

306
TOTAL DEPARTMENT PERSONNEL

9
RESEARCH PERSONNEL WITH DOCTORATES



Educational attainment of regular and fixed-term employees in the Research Division: Nine doctorates, 12 master's, 30 bachelor's, three vocational, and one high school

Summary of Staff Development Program grants in 2022

Type of grant	Coverage	Inclusive dates	Recipients
Doctorate Study Grant	Leave with pay, medical insurance, accident insurance, relocation allowance in support of Japanese Government Scholarship (Nagasaki, Japan)	October 2022–September 2025	1
Conference Attendance	Travel and attendance to World Conference on Agriculture, Food, and Nutrition (Valencia, Spain)	24-25 October 2022	1 (oral presenter)
Conference Attendance	Travel and attendance to 77th Philippine Institute of Certified Public Accountants (PICPA) Annual National Convention (Cebu City, Philippines)	23–26 November 2022	2

Research paper on aquaculture-aided resource enhancement conferred with Elvira O. Tan award

A SEAFDEC/AQD research paper showing that abalone seeds produced in hatcheries can be used to rehabilitate its fisheries in marine reserve multi-use buffer zones was conferred with the Dr. Elvira O. Tan award as an outstanding published paper in the aquatic sciences category.

Lead author Dr. Nerissa Salayo received the award from the Department of Science and Technology - Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development during their 50th Founding Anniversary held last 10 November 2022, at the Council's headquarters in Los Baños, Laguna.

The paper, "Stock Enhancement of Abalone, *Haliotis asinina*, in Multi-Use Buffer Zone of Sagay Marine



Photo courtesy of DOST-PCAARRD

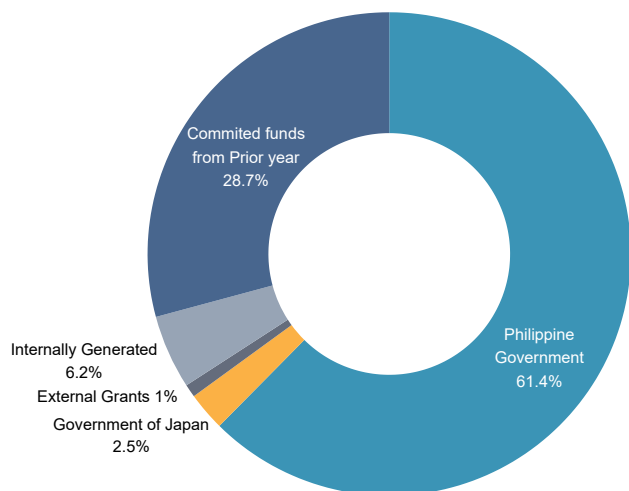
Reserve in the Philippines" was published in the Aquaculture journal in 2020 by Salayo and co-authors Teruo Azuma, Raisa Joy Castel, Rafael Barrido, Dianne Hope Tormon-West, and Takuro Shibuno.

The Dr. Elvira O. Tan award honors Filipino scientists and researchers for their outstanding research publications, which contribute to PCAARRD's mission of advancing the Philippine's economic and food security.

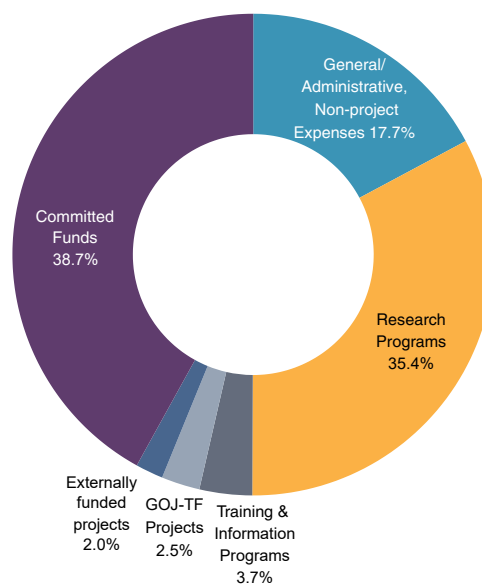
Summary of grants received

Organization	Scope	Amount (USD)
University of Sunshine Coast	Increasing technical skills support community-based sea cucumber production in Viet Nam and the Philippines	33,285
BFAR-Central Office	Preparation of feasibility studies for the legislated hatcheries in Basilisa, Dinagat Island and Tibiao, Antique	17,936
Japan International Research Center for Agricultural Sciences (JIRCAS)	Assessment and development of an Intermediate Culture System for tropical aquaculture species	13,619
Japan International Research Center for Agricultural Sciences (JIRCAS)	Improvement of larval settlement and postlarval production for abalone <i>Haliotis asinina</i> and sandfish <i>Holothuria scabra</i>	7,868
Food and Agriculture Organization	Digitization and Aquatic Sciences and Fisheries Abstracts record preparation of conference proceedings published by SEAFDEC Secretariat, Training Department, Marine Fisheries Research Department, Marine Fishery Resources Development and Management Department and Aquaculture Department	9,107
SEAFDEC Secretariat	Identification of tropical anguillid eels from selected natural habitats in the Philippines using environmental DNA assay	6,517
The Scottish Association for Marine Science Global Seaweed STAR	Safeguarding the future of the Seaweed Industry of the Philippines: Disease and Pest Detection	5,415
Department of Science and Technology Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD)	Molecular mechanisms underlying <i>Scylla serrata</i> response to white spot syndrome virus (WSSV) infection: metagenomic and transcriptomic approaches	5,134
TOTAL		98,881

2022 Sources of funds



2022 Application of funds



Statement of Sources and Application of Funds

SOURCES OF FUNDS	USD	APPLICATION OF FUNDS	USD
Contributions from the Government of the Philippines	5,829,073.63	General, Administrative & Non-project Expenses	1,675,178.85
Government of Japan Trust Fund (GOJ-TF)		Program activities	
Development of strategies and technologies for aquaculture production in Southeast Asia	45,000	Research programs	3,362,022.29
Development of procedures in disease control and management against shrimp and fish disease in Southeast Asia	40,000	Information programs	215,702.23
Capacity Enhancement on Sustainable Aquaculture and Aquatic Animal Health Management in Southeast Asia	30,000	Training programs	131,345.71
Tropical eel culture	60,000	Sub-total	5,384,249.09
Progress management of project	66,241	Projects of GOJ-TF	
Sub-total	6,070,314.63	Development of strategies and technologies for aquaculture production in Southeast Asia	45,420.26
External Grants		Development of procedures in disease control and management against shrimp and fish disease in Southeast Asia	40,226.34
Molecular mechanisms underlying <i>Scylla serrata</i> response to WSSV infection	5,134.07	Capacity Enhancement on Sustainable Aquaculture and Aquatic Animal Health Management in Southeast Asia	29,989.99
Digitisation & ASFA record preparation of conference proceedings published by SEAFDEC Secretariat, TD, MFRD, MFRDMD and AQD	9,107.48	Progress Management of Project	65,926.02
Safeguarding the future of the seaweed industry of the Philippines: disease and pest detection	5,414.69	Tropical eel culture	59,678.39
Identification of tropical anguillid eels from selected natural habitats in the Philippines using environmental DNA assay	6,517.34	Sub-total	241,241
Improvement of larval settlement and post-larval production for abalone <i>Haliotis asinina</i> and sandfish <i>Holothuria scabra</i>	7,867.38	Externally-funded projects	
Assessment and development of an intermediate culture system for tropical aquaculture species	13,619.35	NFRDI	88,456.34
Increasing technical skills supporting community-based sea cucumber production in Viet Nam and Philippines.	33,284.99	JIRCAS	18,581.62
Preparation of feasibility studies for the legislated hatcheries in Basilisa, Dinagat Island and Tibiao, Antique	17,935.61	DOST	465.18
Sub-total	98,880.91	BFAR	11,791.19
Internally generated		ASFA Trust Fund- FAO	9,319.02
Research Division	76,981	ACIAR	52,221.45
Training & Information Division	72,522.11	JAIF	7,539.65
Technology Verification & Extension Division	228,120.71	Sub-total	188,374.44
Administrative & Finance Division	214,383.55	Committed Funds	
Management Group	258.34	On-going activities	629,394.91
Sub-total	592,265.71	Capital outlay/repairs	3,045,135.81
Committed funds from prior year	2,726,934	Sub-total	3,674,530.72
TOTAL SOURCES OF FUNDS	9,488,395.25	TOTAL APPLICATION OF FUNDS	9,488,395.25

Conversion: US\$1.00 = PHP55.755

Collaboration in 2022

Academe

Partner Institution	Nature of collaboration	Period
John B. Lacson Foundation Maritime University-Arevalo	Research collaboration	17 Feb 2017– 31 Jan 2022
St. Paul University Iloilo	Collaboration in undertaking research, instruction, training, and extension programs	25 Oct 2019– 24 Oct 2024

Government and Non-Government Organizations

Partner Institution	Nature of collaboration	Period
Panay Aqua Farmers Consumers Cooperative (PAFCC)	Planning and set-up of low-cost feed mill in Capiz Province	Sep 2021– Jan 2024
Mindanao Development Authority (MinDa)	Techno-transfer program: Conduct training in broodstock, hatchery, nursery, and grow-out operations of commercially viable finfishes, crustaceans, mollusks, and seaweeds	2021–2024
Bureau of Fisheries and Aquatic Resources (BFAR) Region 6	National Bangus Fry Sufficiency Program: Conduct an assessment of existing hatcheries in the region, prepare plans and cost estimates of identified priority hatchery for rehabilitation, and extend necessary technical assistance in the hatchery operation	2020–2025
Japan International Research Center for Agricultural Sciences (JIRCAS)	Implementation of research projects: Provide technical assistance to visiting scientist from JIRCAS	29 March 2022– 31 March 2026
National Fisheries Research and Development Institute (NFRDI)	Aquaculture Feed Development in the Philippines: Assessment of raw materials and alternative to fishmeal; feed formulation using low cost raw materials and feed ingredients; pilot testing of the formulated feeds; conduct training on feed preparation and feed formulation	ongoing
NFRDI	Aquafeed Research, Development and Extension Project (ARDEP): Cooperating agency and member of the Technical Working Group in the implementation of the project; submit proposal on the aquafeed research, development and extension; conduct and implement the study in accordance with the approved Project Proposal	Sep 2018– Dec 2022
Pipindan Aquaculture Producers Association (PAPA)	Community-Based Sustainable Aquaculture Livelihood (CBSAL): Provide assistance to Pipindan LGU and PAPA in producing basic design, operation guide, and feasibility study for giant freshwater prawn hatchery and nursery to produce PL for grow-out culture to support livelihood and supplement food of fisherfolk communities in Laguna Bay	ongoing
BFAR	Feasibility Studies for the two Multi-species Marine or Freshwater Hatchery/Nursery projects: Provide services in the conduct and preparation of feasibility studies and related documents for the 2 multi-species marine or freshwater hatchery/nursery projects in Tibiao, Antique and Dinagat Islands	until June 2023

Heads of Offices in 2022

Executive Committee

Chief	Mr. Dan Baliao
Deputy Chief	Dr. Sayaka Ito
Head, Research Division	Dr. Leobert de la Peña
Head, Technology Verification & Extension Division	Dr. Roger Edward Mamauag
Head, Training & Information Division	Dr. Edgar Amar
Head, Administration & Finance Division	Ms. Amelita Subosa

Program Leaders

Quality Seed for Sustainable Aquaculture	Dr. Maria Rowena Eguia
Healthy & Wholesome Aquaculture	Dr. Mae Catacutan, Dr. Eleonor Tendencia
Maintaining Environmental Integrity through Responsible Aquaculture	Dr. Jon Altamirano
Meeting Social & Economic Challenges in Aquaculture	Dr. Nerissa Salayo
Regional Programs	Dr. Sayaka Ito

Station Heads/OIC

Binangonan Freshwater Station	Dr. Frolan Aya
Dumangas Brackishwater Station	Dr. Roger Edward Mamauag
Igang Marine Station	Mr. Mateo Paquito Yap
Manila Office	Ms. Christine Joy Catig

Section Heads/OIC

Research Division

Breeding & Seed Production	Dr. Shelah Mae Ursua
Fish Health	Dr. Eleonor Tendencia (until 03 March 2022) Dr. Leobert de la Peña (beginning 04 March 2022)
Nutrition & Feed Development	Mr. Joseph Biñas
Farming Systems & Ecology	Dr. Jon Altamirano
Socioeconomics	Dr. Nerissa Salayo

Technology Verification & Extension Division

Technology Verification	Dr. Roger Edward Mamauag
Extension & Packaging	Ms. Erish Estante

Training & Information Division

Training	Mr. Caryl Vincent Genzola
Development Communication	Mr. Rex Delsar Dianala
Library & Databanking Services	Mr. Daryl. Superio (until 14 Sep. 2022) Ms. Mary Grace Oliveros (beginning 15 Sep. 2022)

Administration & Finance Division

Engineering	Engr. Hermoso Igcasan Jr.
Human Resources Management	Ms. Sunshine Mae Salonga
Budget-Cashiering	Ms. Jiji Rillo
Accounting	Mr. Isiah Keish Torres

SNAPSHOTS: AQD hosting of 2022 SEAFDEC Meetings

This year, SEAFDEC/AQD, in cooperation with the SEAFDEC Secretariat, hosted the Forty-fifth Meeting of the SEAFDEC Program Committee (45PCM) held on 5–7 Dec. 2022 in Iloilo City, Philippines. This was followed by the Twenty-fifth Meeting of the Fisheries Consultative Group of the ASEAN-SEAFDEC Strategic Partnership

(25FCG/ASSP) convened on 8–9 Dec. and the Department Chief’s Meeting (DCM) on 10 Dec.

The meetings were attended by about 60 delegates from SEAFDEC Secretariat, senior SEAFDEC departments officials, and 11 member-countries.

Atty. Demosthenes Escoto, BFAR officer-in-charge, delivered the key-

note message of Philippine President Ferdinand Marcos, Jr. which reiterated the host government’s support to SEAFDEC.

While held mostly in a hotel venue, the delegates also toured SEAFDEC/AQD’s aquaculture facilities in Tigbauan, Iloilo as well as historical sites in Iloilo City.





Southeast Asian Fisheries Development Center
AQUACULTURE DEPARTMENT
www.seafdec.org.ph

The Southeast Asian Fisheries Development Center (SEAFDEC) is a regional treaty organization established in December 1967 to promote fisheries development in the region. The member countries are Brunei Darussalam, Cambodia, Indonesia, Japan, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand and Viet Nam.

The policy-making body of SEAFDEC is the Council of Directors, made up of representatives of the member countries.

SEAFDEC has five departments that focus on different aspects of fisheries development:

- The Training Department (TD) in Samut Prakan, Thailand (1967) for training in marine capture fisheries
- The Marine Fisheries Research Department (MFRD) in Singapore (1967) for post-harvest technologies
- The Aquaculture Department (AQD) in Tigbauan, Iloilo, Philippines (1973) for aquaculture research and development
- The Marine Fishery Resources Development and Management Department (MFRDMD) in Kuala Terengganu, Malaysia (1992) for the development and management of fishery resources in the exclusive economic zones of SEAFDEC member countries, and
- The Inland Fishery Resources Development and Management Department (IFRDMD) in Palembang, Indonesia (2014) for sustainable development and management of inland capture fisheries in the Southeast Asian region.

AQD is mandated to:

- Conduct scientific research to generate aquaculture technologies appropriate for Southeast Asia
- Develop managerial, technical and skilled manpower for the aquaculture sector
- Produce, disseminate and exchange aquaculture information

SEAFDEC/AQD maintains four stations: the Tigbauan Main Station and Dumangas Brackishwater Station in Iloilo Province; the Igang Marine Station in Guimaras province; and the Binangonan Freshwater Station in Rizal province. SEAFDEC/AQD also has a Manila Office in Quezon City.