



**Asia-Pacific
Economic Cooperation**

Advancing Free Trade
for Asia-Pacific **Prosperity**

**Project Report:
Report and Workshop on Capacity Building to Improve
Economic Reactivation in Sustainable Aquaculture**

APEC Ocean and Fisheries Working Group

July 2023



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EXECUTIVE SUMMARY

Since the World Health Organization (WHO) declared COVID-19 a global pandemic, more than three years have passed. The aquaculture sector has overcome the macroeconomic impact but may still be experiencing residual effects. Additional stressors such as a persistent global inflation have affected aquaculture, resulting in higher inputs and commodity prices. **Recovery from the pandemic and additional stressors for the sector has remained uneven and among the most affected groups is Small-Scale Aquaculture (SSA).**

Small and Medium-sized Enterprises (SMEs) are a crucial component of most economies, as highlighted by the World Trade Organization which reports that they account for over 90% of the business population, 60-70% of employment and 55% of the gross domestic product (GDP) globally. The aquaculture industry is no exception, with approximately 70-80% of all fish farming participants worldwide being categorized as small-scale. Additionally, SSA plays a vital role in socio-economic development, poverty alleviation, and food security. Despite these contributions, SSA businesses are often vulnerable due to their informality, limited or non-existent access to finance and low skill level.

To date, there has been no systematic analysis of the extent of COVID-19 constraints on the aquaculture sector in the APEC region. Neither regarding the sectoral actions taken by policymakers to mitigate these constraints. Assessing the performance of the sector and the actions taken will assist local, regional and economy-wide policymakers by providing a better view of the main challenges faced by different economies and thus determining appropriate interventions and assisting in setting priorities and allocating resources based on the diversity of measures taken by different governments of the region.

The objective of the project was to assess the impact of the COVID-19 pandemic on the aquaculture sector in the APEC region, to map the measures taken by APEC economies to deal with these effects, and to develop policy recommendations and improve policy responses to the lingering effects of the pandemic and future similar shocks, **with emphasis on measures for economic recovery and improving the sustainability and resilience of the SSA sector.** This final report provides data on policies, actions, measures, programs and/or experiences implemented by APEC economies that have had an impact on the economic reactivation of small and medium-sized aquaculture companies. obtained from a research report and a virtual two-day workshop developed on the topic.

The present report was formulated following an initial research report including scientific, technical and governmental socioeconomic public data, answers to a digital questionnaire and interviews to policy makers and members from intergovernmental organizations and the academy (for summary see [Annex 1](#)), and a virtual two-day workshop with discussions on the topic (for summary see [Annex 6](#)), both methods were used as tools to identify policies, highlighting key aspects and difficulties found by APEC economies when coping with major disruptions caused by COVID-19. The capacity building international workshop was developed virtually. The “Workshop on capacity building to improve economic reactivation, resilience and sustainability of aquaculture within the context of recovery of the COVID-19 pandemic” was held on 16-17 March 2023, and organized by the General Direction of Aquaculture from the Ministry of Production of Peru and the consulting company Equilibrium SDC, based in Lima, Peru for the OFWG of APEC. The event allowed to develop recommendations to enhance the economic recovery, resilience and sustainability of the aquaculture sector. The participants for this event were mostly female (60%), including the speakers (56%) which allowed to accomplish one of the objectives of the project related to at least 30% women participation.

The report is divided into **four main sections** covering the following topics: **(1)** the state of the aquaculture in the APEC region (before and after COVID-19); **(2)** specific impacts of the pandemic on the aquaculture value chain (AVC) of APEC economies; **(3)** actions and recovery measures taken by APEC economies to mitigate such impacts; and **(4)** general recommendations and conclusions for the improvement of the economic recovery, sustainability, and resilience in the

post-pandemic aquaculture sector. Brief descriptions and key findings for each section are presented next:

Section 1: State of the aquaculture sector in the APEC region - This section provides insights into the relevance of aquaculture to the APEC region, trends developed in the past decade, and outlines the size of the COVID-19 shock during the first year of the pandemic (2020) for key socio-economic parameters (production performance, employment performance and trade in fish¹ commodities) at the regional and individual member levels, and gives insights into the recovery phase (2021-2022). Aquaculture in the APEC region grew 1.6% during 2020 which was an achievement amid the 3.3% decline in the world economy in the same year. The aquaculture sector in Canada; Chile; Indonesia; Peru; Singapore and the United States were among the most affected in the first year of the pandemic. Finally, clear signs of recovery have been identified since 2021 and in 2022 the market and demand of fishery products recovered completely, and the commerce reached new records in macro terms.

Section 2: Major disruptions of COVID-19 in the aquaculture value chain – Aquaculture was one of the food sectors most directly affected by COVID-19. In this section, the disruptions to the different stages of the AVC are classified into labor disruptions, supply chain and production disruptions, market demand and prices disruptions, financial disruptions, impacts on seafood consumption, and exacerbation of sex and gender inequalities. Details on the aspects of each topic are presented and specific examples for APEC economies (including case studies) are brought into the discussion as a mechanism to highlight the most relevant issues and situate the need for mitigation policies. The pandemic also had positive trends such as the use of online platforms for trade and the increase of the consumption of processed food, exacerbated use of social media for marketing and empowering of local urban communities to produce their own food.

Section 3: Policy mapping of actions taken by APEC economies to support aquaculture- Several transversal and sectoral measures have been taken by governments to ensure social protection, guarantee decent working conditions for fish farmers² and to secure the seafood supply chain. Here, the measures were divided into health and safety measures, financial assistance, social protection, supply chain and marketing measures, management and technical measures, digitalization and innovation, and promoting sustainability and resilience. First and foremost, it was important to declare the sector essential. Financial support was the number one measure requested by farmers but the high informality and lack of social protection of SSA enterprises in developing economies made it difficult to access economic support packages. Other measures were taken to ensure the continuity of fish food supply, such as expanding access to local or rural markets, supporting economy-wide and local production through consumer awareness campaigns, and promoting e-governance and e-commerce.

Section 4: Conclusions and policy recommendations - Based on all the previous sections, gaps and opportunities for improvement were identified. The general recommendations for an APEC strategy were divided into short- and long-term actions. The main objective of the policy recommendations for the short-term is to outline the best immediate response to future pandemics or similar challenges and the best measures to mitigate the residual effects of the COVID-19 pandemic. Meanwhile the proposed long-term actions seek to take advantage of this exceptional opportunity to enhance the resilience and sustainability of the aquaculture sector and small-scale fish farmers while also embracing the positive trends exacerbated by the pandemic.

This project was funded by the APEC Oceans and Fisheries Working Group: OFWG 05 2021.

¹ We use the term fish commodities to refer to all products obtained from aquatic food systems (including capture fisheries).

² We use the term fish farmers to refer to all farmers of aquatic food products.

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LIST OF ABBREVIATIONS

AMYPE	Micro and small aquaculture
AREL	Limited resources aquaculture or subsistence aquaculture
AUD	Australian dollar
BFAR	Bureau of Fisheries and Aquatic Resources from The Philippines
CAD	Canada dollar
CARES Act	Coronavirus Aid, Relief and Economic Security Act
EIDL	US Economic Injury Disaster Loans
EU	European Union
FAO	Food and Agriculture Organization
FONDEPES	Peruvian Fisheries Development Fund
GDP	Gross Domestic Product
HORECA	Hotels, Restaurants and Catering sector
IFAM	Australian International Freight Assistance Mechanism
ILO	International Labor Organization
IYAFA	International Year of Artisanal Fisheries and Aquaculture
ISSCAAP	International Standard Statistical Classification of Aquatic Animals and Plants
KRW	Korean Won
LPMUKP	Indonesian Maritime and Fisheries Business Capital Management Institute
MARD	Viet Nam's Ministry of Agriculture and Rural Development's
MYR	Malaysian Ringgit
MMAF	Indonesian Ministry of Marine Affairs
NGOs	Non-Governmental Organizations
NTD	New Chinese Taipei Dollar
OECD	Organization for Economic Co-operation and Development
OFWG	Oceans and Fisheries Working Group
PEN	Peruvian soles
PPE	Personal Protective Equipment
PHP	Philippine peso
R&D	Research and Development
SMEs	Small and Medium-sized Enterprises (SMSEs)
SDGs	Social Development Goals
SANIPES	Peruvian Fisheries Health Organization
SEAFDEC	Southeast Asian Fisheries Development Center
SERNAPESCA	Chilean Fisheries and Aquaculture Service
SGD	Singapore Dollar
SSA	Small-Scale Aquaculture
SSAFA	Small-Scale Artisanal Fisheries and Aquaculture
SPPR	Seafood Processors Pandemic Response
THB	Thai Baht
UNDP	United Nations Development Programme
USAID	The United States Agency for International Development
USD	United States Dollar
USDA	US Department of Agriculture
Virginia AREC	Virginia Seafood Agricultural Research and Extension Center
WB	World Bank
WHO	World Health Organization

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INTRODUCTION

Since early 2020, the SARS-CoV-2 (COVID-19) pandemic has spread rapidly around the globe. WHO declared it a global pandemic on 11 March 2020 and called on economies to take urgent and aggressive action to contain the spread of the virus (WHO, 2020). Since then, the disease has killed almost seven million people and rendered hundreds of millions ill. To contain the health risks, most economies introduced unprecedented restrictions and lockdown measures, **confronting policymakers with a dilemma**: the imposition of strict closures and social distancing mandates to reduce the risk of infection and, on the apparently opposite side, the adoption of less rigid mitigation measures to minimize economic consequences.

Aquaculture is a major source of food for the global community; it supplies around 56% of the total aquatic animal food production available for human consumption (FAO, 2022a). The aquaculture sector's contribution to the supply of fish for human consumption surpassed that of wild-caught fish for the first time in 2014 (FAO, 2016). Furthermore, capture fisheries resources are mostly overfished, and their production has not increased since the 1990s. Meanwhile, aquaculture is the fastest-growing food production sector in the world with an average annual growth rate of 6.7% during the period 1990-2020 (FAO, 2022b). Fisheries and aquaculture are a source of income for over 10% of the world's population (OECD, 2020), providing relatively affordable, accessible, high-protein products that contribute to food and nutrition security, especially in low-income economies (Troell et al., 2019). Hence, **aquaculture is both the present and the future to meet the growing global demand for fish and seafood products**, and a low carbon emission product that can contribute to global food sustainability.

Aquatic species are not infected with SARS-CoV-2 or pose a risk of transmission to humans (Bondad-Reantaso et al., 2020; Godoy et al., 2021). However, the pandemic and the responses to it initially caused a major shock to aquaculture practices, and the highly globalized nature of the sector allowed it to spread very fast across all regions of the world (Ahmed & Azra, 2022; Alam et al., 2022; Belton et al., 2021; Jamwal & Phulia, 2021; Love et al., 2021; Mangano et al., 2022; Sarà et al., 2022). A significant number of aquaculture producers had to temporarily cease production or severely reduce their aquaculture practices during the pandemic. Lockdown measures and restrictions on movement and transportation affected the mobility of fish farmers to work, disrupted the aquaculture supply chain, fish demand and prices, and international trade in fish products, with severe impacts on finances, livelihoods, food security, and nutrition (Mangano et al., 2022; Manlosa et al., 2021). Closed borders, travel restrictions, and disruptions in trade flows have affected economies that rely on exports of aquatic products. Lockdowns and "stay at home" orders combined with restrictions on tourism, affected the local demand for aquaculture products. Fish is highly perishable and thus extremely vulnerable to supply chain disruptions, making it one of the agricultural products most affected by COVID-19.

The disproportionate magnitude and persistence of the economic impact of the pandemic forced governments and all aquaculture stakeholders to take immediate and adaptive measures to combat it. However, in order to **make correct decisions regarding aid, it is necessary to diagnose the state of the aquaculture sector to carry out interventions and manage solutions to priority problems**. Assessing the impact of COVID-19 on the aquaculture sector requires that governments, academia, civil associations, companies, farmers, and workers share information on the main impacts of local, regional, and international trade on the aquaculture supply chain. To further characterize the impacts of COVID-19 on AVC, qualitative and quantitative assessments are needed.

In this context, **APEC economies, which account for more than 80% of the world's aquaculture production**, have taken various measures to minimize the economic impact and guarantee the economic reactivation of the sector. Nonetheless, a regional assessment of the benefits of these measures has yet to be carried out. Therefore, it is necessary to call upon aquaculture sector officials and policymakers to share the experiences and results of the initiatives, which will benefit the actors involved and will provide a baseline on the impact of economic reactivation initiatives for SMEs in the APEC region. The benefits of economic

reactivation programs in the region must reach aquaculture producers, to ensure the continuity of their activities through specific policies or programs.

Some reports indicate that government assistance to the small-scale sector (both fisheries and aquaculture) has been less definitive in developing economies, possibly as a consequence of the limited information available on the economic impact of COVID-19 for SSA, and the composition of the sector, with thousands of independent or informal actors as owner-operators, micro-enterprises or small businesses, and a fragile network of markets, mostly without formal financial records or connected to financial institutions (FAO, 2020e).

This is neither the first, nor the last pandemic, consequently, **it is essential not only to guarantee economic recovery but also to establish a resilience approach to address similar concerns in the future**. Collaboration between aquaculture major stakeholders is pivotal, including international and government agencies, corporations, associations, farmers, researchers, donors, and policymakers is important to establish more resilient and sustainable aquaculture practices against the remaining challenges of COVID-19 and future similar shocks or stressors to the sector. Globally, there is an urgent focus on food security to mitigate the challenges posed by the potential occurrence of future viral pandemics, such as that caused by SARS-CoV-2, and to protect vulnerable critical supply chains. Scientific evidence must always shape effective responses to the impact of such stressors on aquaculture systems.

Therefore, the objective of this report is to develop an integrated analysis of best practices and recommendations to contribute to the implementation of economic reactivation measures for the aquaculture sector in APEC economies with a sustainable approach. To achieve this objective, the report first provides a comprehensive diagnosis of the impact of COVID-19 and related sanitary-risk mitigation measures on the aquaculture sector in the APEC region, and next presents and discusses the implications of immediate and medium-term mitigation measures for the sector. The methodology used to prepare this report is shown in [Annex 2](#).



I. SECTION 1: OVERVIEW OF THE AQUACULTURE SECTOR IN THE APEC REGION BEFORE AND AFTER THE COVID-19 PANDEMIC

Key messages:

- » The APEC region is the most important aquaculture region in the world, producing more than 81.8% of the total volume and value of aquaculture products.
- » The aquaculture sector in the APEC region experienced the lowest growth rate (1.6%) in the past decade during the first year of the pandemic (2020).
- » The People's Republic of China³ ensured the growth of the aquaculture sector in the APEC region and the world during the first year of the pandemic growing by 3%.
- » The aquaculture industries of APEC economies were not equally affected by the pandemic.
- » The impact of COVID-19 on the aquaculture sector of the APEC region in 2020 was more severe for the value of farmed products, than for the volume of aquaculture products.
- » The aquaculture sector in Canada; Chile; Indonesia; Peru; Singapore and the United States were the most affected in the first year of the pandemic, when considering data for both the total volume and value of aquaculture products.
- » The aquaculture sector in Australia; Brunei Darussalam; China; Malaysia and Russia experienced considerable increases in both total volume and value of aquaculture products during 2020.
- » Most of the exports of seafood products decreased in APEC economies in 2020, except for Brunei Darussalam and Indonesia.

The present report includes quantitative and qualitative data collected from all 21 APEC economies through primary and secondary sources, including responses to a digital questionnaire ([Annex 3](#) and [Annex 4](#)) and interviews ([Annex 5](#)), and discussions from a two-day virtual workshop applied to policy makers. A summary of the initial research report developed and the complete methodology used to elaborate the present report can be seen in [Annex 1](#) and [Annex 2](#), respectively. While a summary of the virtual workshop can be found in [Annex 6](#).

This first section is based on data from FAO's database (FishStatJ) on aquaculture production volumes and values and total trade value of fishery products (exports and imports) for global, continental, regional, and individual production from the 21 APEC economies for the period 2011-2020. Additionally, the OECD Agriculture Statistics database (https://stats.oecd.org/Index.aspx?DataSetCode=FISH_AQUA#) on employment in aquaculture for 17 reporting APEC economies (data not available for Brunei Darussalam; Hong Kong, China; Papua New Guinea and Singapore) and data from the World Bank were used.

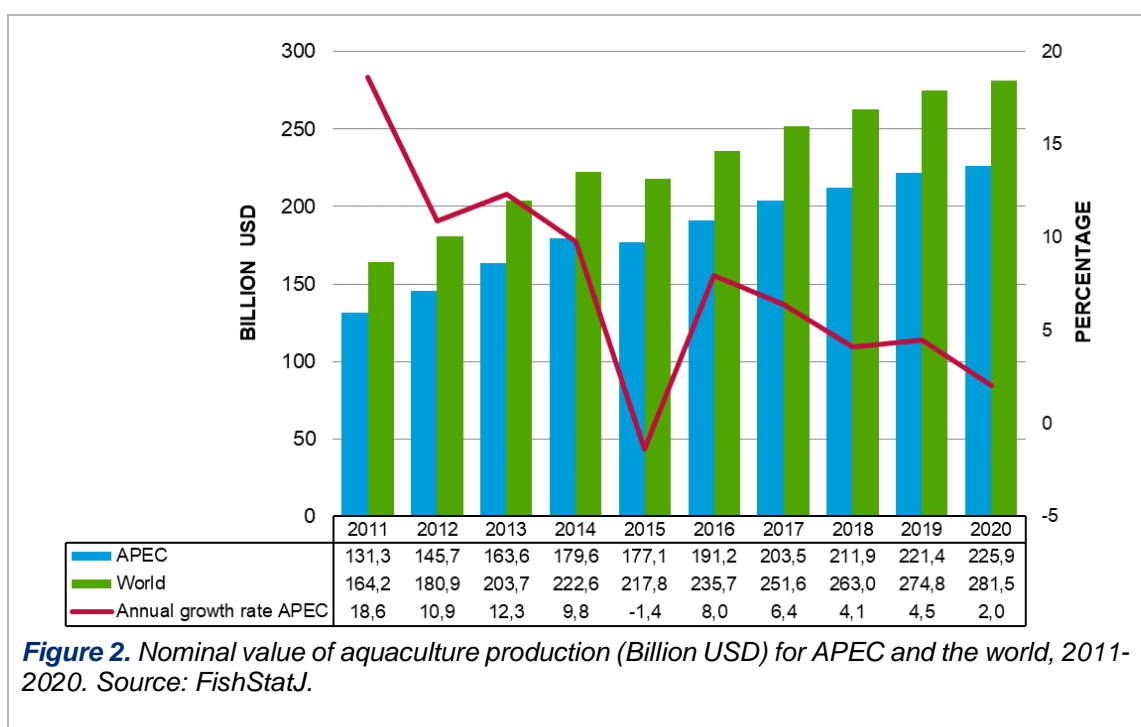
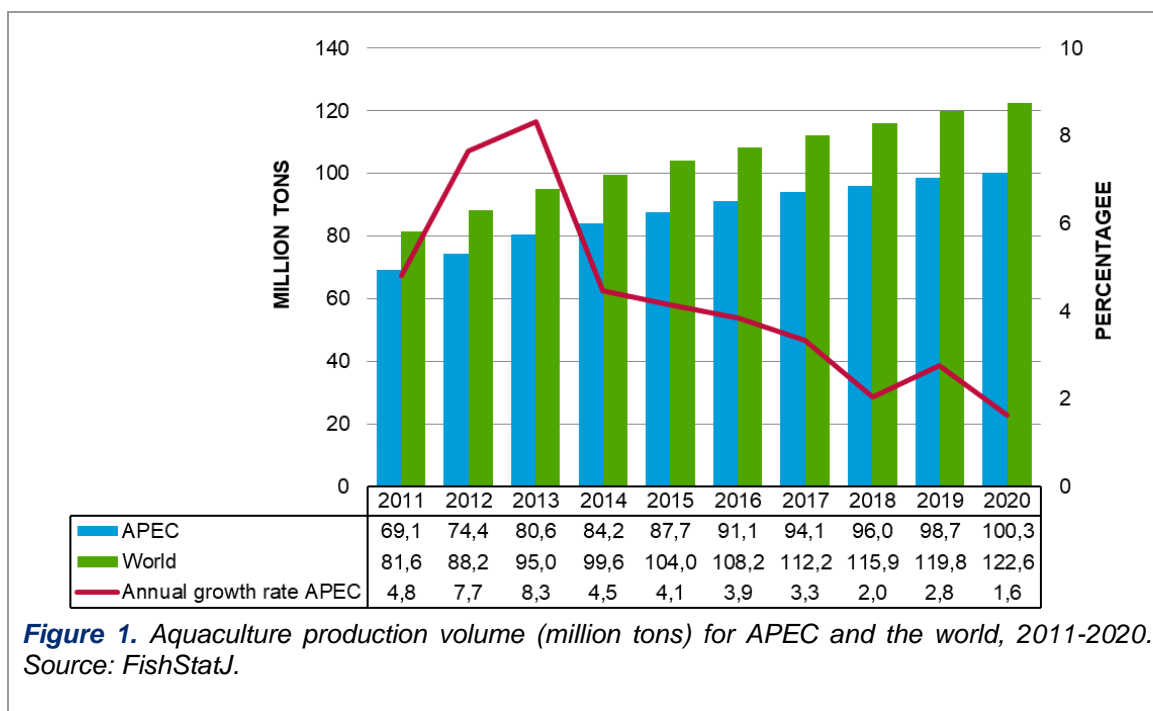
I.1. Socio-economic impact of the COVID-19 pandemic at the regional level

I.1.1. Regional productive performance

The APEC region is by far the most important aquaculture region in the world. Of the world's top 10 aquaculture producers, five are in the region: China (1st), Indonesia (3rd), Viet Nam (5th),

³ Hereinafter "China".

Chile (8th) and Thailand (10th) (FAO, 2022b). In 2020, the region's total aquaculture production reached 100.3 million tons accounting for 81.8% of the world's aquaculture production volume (122.6 million tons) (Figure 1), and USD225.9 billion (USD, United States dollar), corresponding to 80.3% of the world's aquaculture production value (USD281.5 billion) (Figure 2).



The total aquaculture production volume of the APEC region grew by 1.6% in 2020 compared to 2019, the lowest in the past 10 years (Figure 3), and well below the average annual growth rate in the period 2011-2019 (4.6%) showing the size of the COVID-19 shock in the region (Table 1). Nonetheless, **the overall increase was an achievement amid the 3.3% decline in the world**

economy in 2020⁴, especially since aquaculture was considered to be a hard-hit sector by the pandemic (Cai et al., 2021).

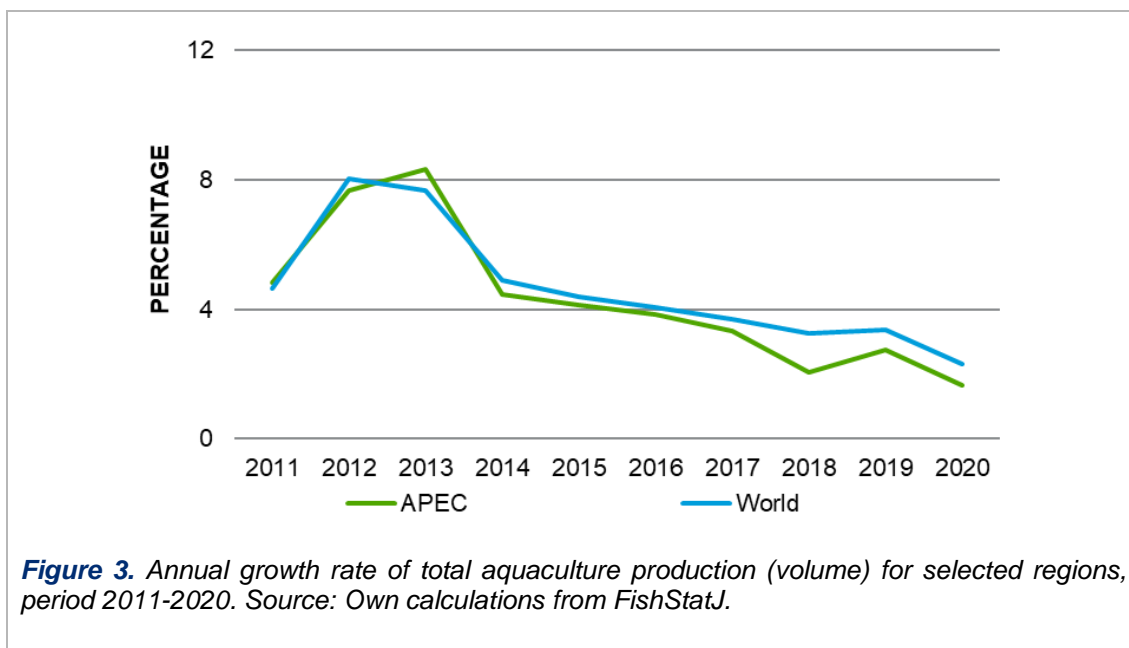


Table 1. Average annual growth rate of total aquaculture production (volume and value) for selected regions in 2011-2020 and 2019-2020.

	TOTAL VOLUME		TOTAL VALUE	
	Average (%)	Growth rate (%)	Average (%)	Growth rate (%)
	2011-2019	2019-2020	2011-2019	2019-2020
APEC	4.6	1.6	8.1	2.0
World	4.9	2.3	7.9	2.5

Source: Own calculations from FishStatJ.

The total value of aquaculture production in the APEC region registered a 2% increase in 2020 compared to 2019, **the second lowest growth of the decade, behind only the decline in 2015 (-1.4%)** (Figure 4). The 2015 decline was related to a mix of global effects that affected both the fisheries and aquaculture sectors, including economic crisis and uneven economic recovery in developing economies (Brazil and Russia), rising geopolitical tensions, weak global investment growth, maturing global supply chains, the effect of an appreciating dollar, strong exchange rate fluctuations and slowing momentum in trade liberalization (FAO, 2016). The performance of the total aquaculture value in the region and in the world in 2020 was better compared to the situation in 2015, if we consider that in 2020, the global economy contracted by 3.3%, while in 2015 the global economy expanded by 3.1%.

⁴ Measured by the World Bank as GDP growth (annual %). Accessed: 18 January 2023. Available in: <https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG>

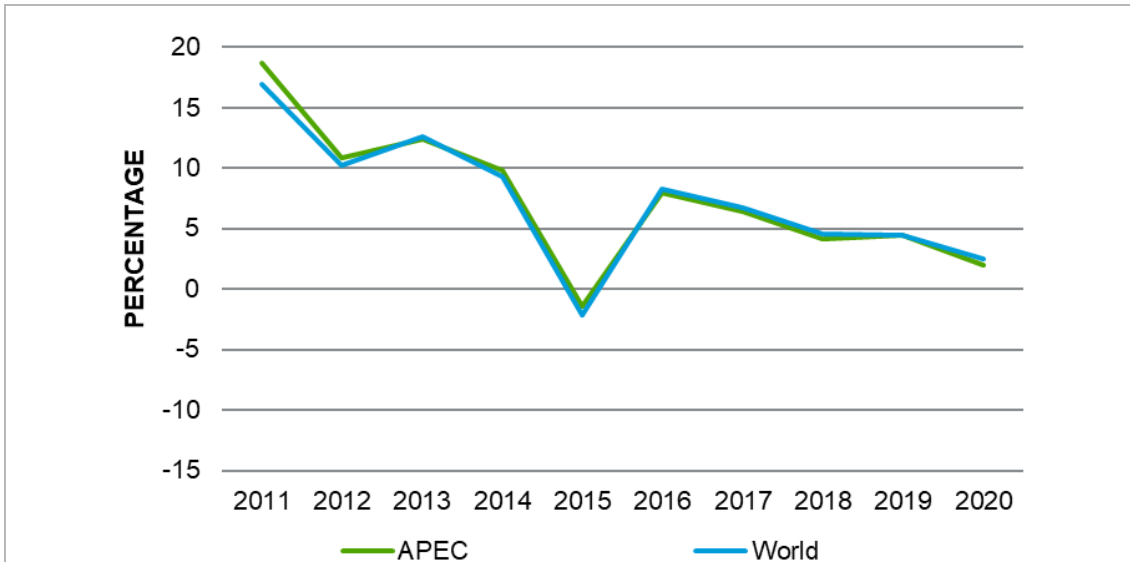


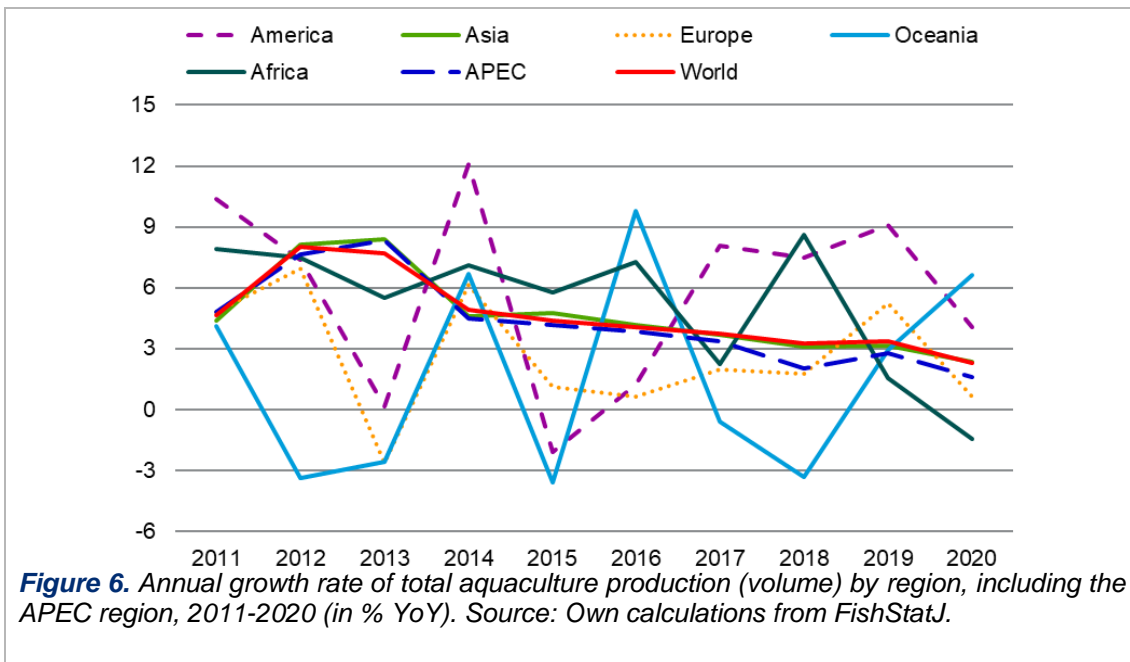
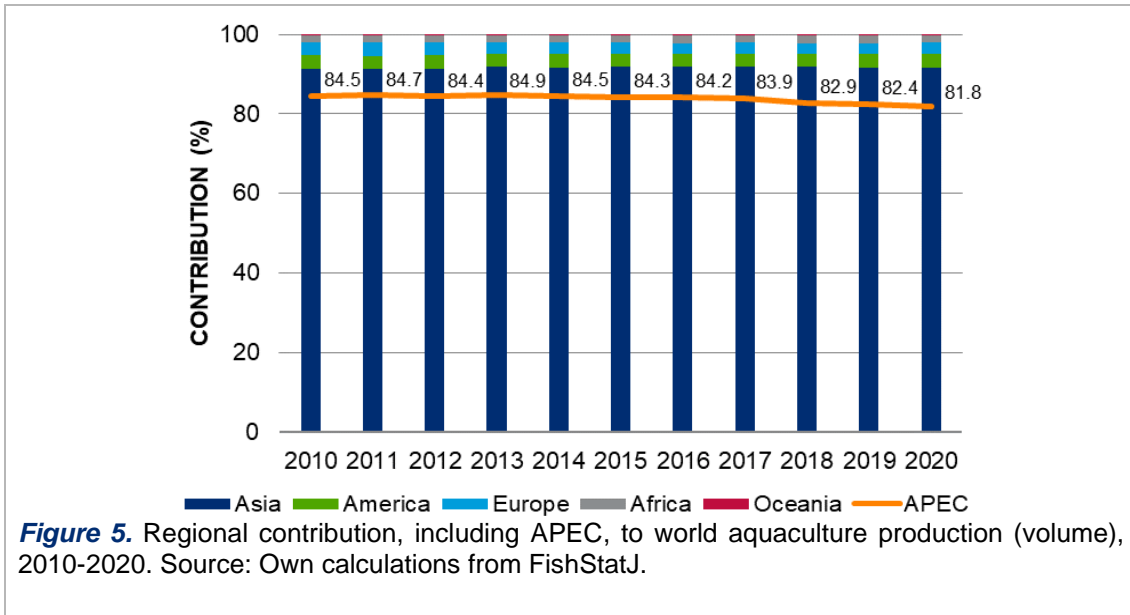
Figure 4. Annual growth rate of total aquaculture production (value) for selected regions, 2011-2020. Source: Own calculations from FishStatJ.

The growth of the region in 2020 was driven by China's increase (4.2%). The total aquaculture production value of the APEC region excluding China actually decreased by 3.8%, more in line with the performance of the world economy, but in contrast with the 2.5% growth of total world aquaculture production and is even less than the non-variation seen when China's contribution is isolated from the world production (Table 1). Due to the large imbalance in aquaculture production among APEC economies, regional patterns may not adequately capture individual variations, which are covered in detail in Section I.2.

Data for 2021-2022 were not available in the FishStatJ, and thus, were not included in this analysis. Nonetheless, in 2022, world aquaculture production's growth is expected to rise by 2.9%, albeit below the previous long-term trend of 4-5%, mainly due to continued caution on stocking rates and input costs (FAO, 2022c).

The contribution of the APEC region to global aquaculture production (volume) registered a constant slight decline over the last decade (2010-2020), while Asia's contribution has remained unchanged (Figure 5). In 2020, the share value from each region in global aquaculture volume production was: Asia (91.6%), APEC (81.8%), America (3.6%), Europe (2.7%), Africa (1.9%), and Oceania (0.2%). When the global aquaculture production value (in 2020) is analyzed, Asia decreases to 85.6%, APEC to 80.3%, America increases to 6.3%, Europe to 5.4%, Africa's contribution remains at 1.9%, and Oceania increases to 0.7%.

APEC and Asia's enormous contribution to world aquaculture forces the trend of the three regions through the same path each year, **showing a steady decline in the average growth rate of total aquaculture production (volume) before the pandemic (since 2013)** (Figure 6), which can be explained by the maturation of the aquaculture sector in the APEC region and the subsequent lower growth rates, particularly in China. On the other hand, America, Oceania, Europe and Africa show different values, with no clear trend during 2011-2020. In 2020, the only continent that registered an actual decrease in aquaculture production (volume) was Africa with -1.4%; the other regions achieved growth in the same year, although a significant decrease in growth rates is observed. Contrarily, Oceania showed an increase of 6.6% over the same period, which was higher than the previous results for 2018 and 2019.

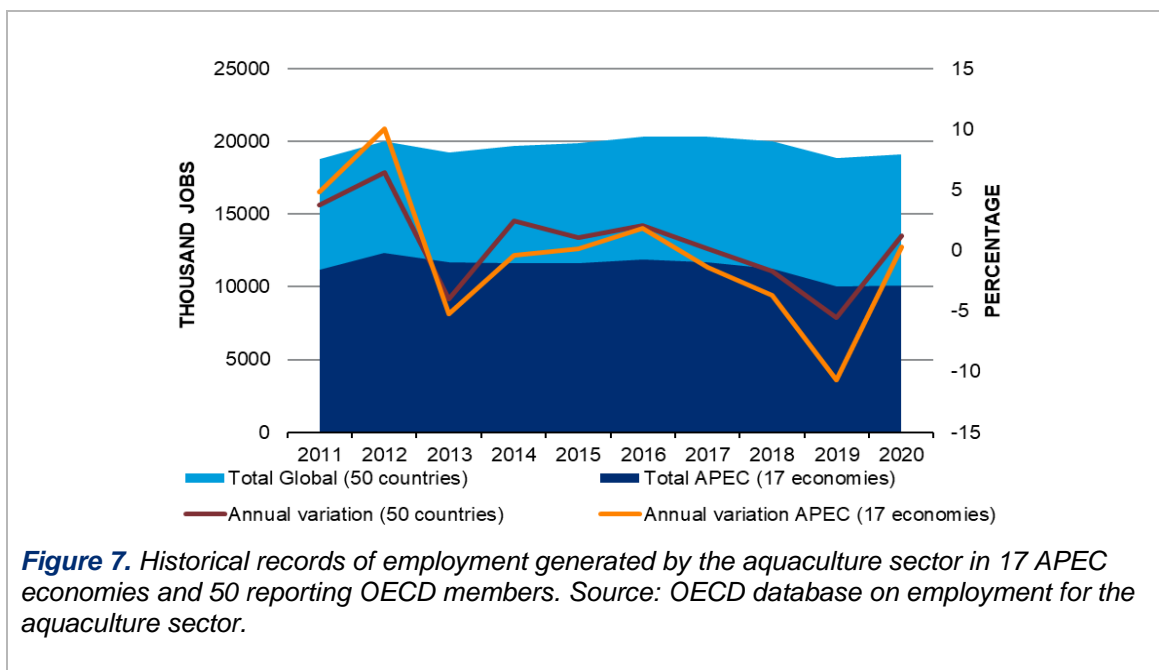


I.1.2. Regional employment performance

Total employment in the aquaculture sector in the APEC region has decreased slightly in recent years (2016-2019) (Figure 7). This decrease has previously been associated with the stabilization of growth in the sector (FAO, 2016). Lower employment generation is usually reported in farms that have received interventions aiming to increase fish productivity (Nasr-Allah et al., 2020), suggesting that the intensification of production and maturation of the sector at the economy-wide level may explain the constant decrease in employment while production is constantly increasing.

Notwithstanding, employment data should be interpreted with caution, as specific employment data for the aquaculture sector are difficult to obtain for several reasons: (1) aquaculture data from all stages are often combined with capture fisheries, (2) informality characterizes SSA production in many developing economies and (3) no recent data on indirect employment generated by aquaculture-related activities are currently available (ILO, 2021). Additionally, official figures are not available for all economies in the OECD's database, and some data are

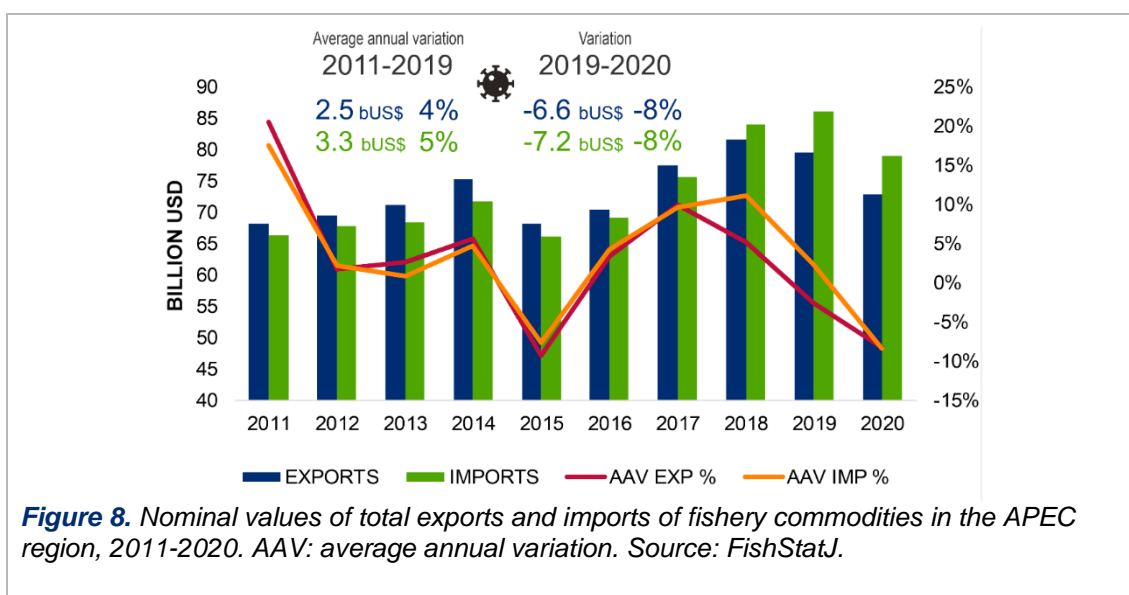
based on estimates. **Governments should make the effort to keep these databases accurately updated**, as they can provide extremely valuable information for policy analysis.



During the past decade (2011-2020), APEC economies (17) have generated an average of 11.3 million jobs per year, with an average annual variation of -0.4%. In 2020, employment in the aquaculture sector in the APEC region accounted for 10,073,772 jobs, 0.3% more than in 2019, but -4.4% less than in 2018, explained by the sharp decline (-10.7%) experienced in 2019 (Figure 7).

I.1.3. Regional trade of fisheries commodities

Thirty-eight % of aquaculture production is traded globally, making aquatic food the most globally traded major food group (Stoll et al., 2021). During the 2011-2020 period, the total value of fish commodity exports in the APEC region, the world’s largest exporter of fish products, followed a mixed trend, but the region showed an average annual increase of USD2.5 billion, or 4% annual variation (Figure 8).



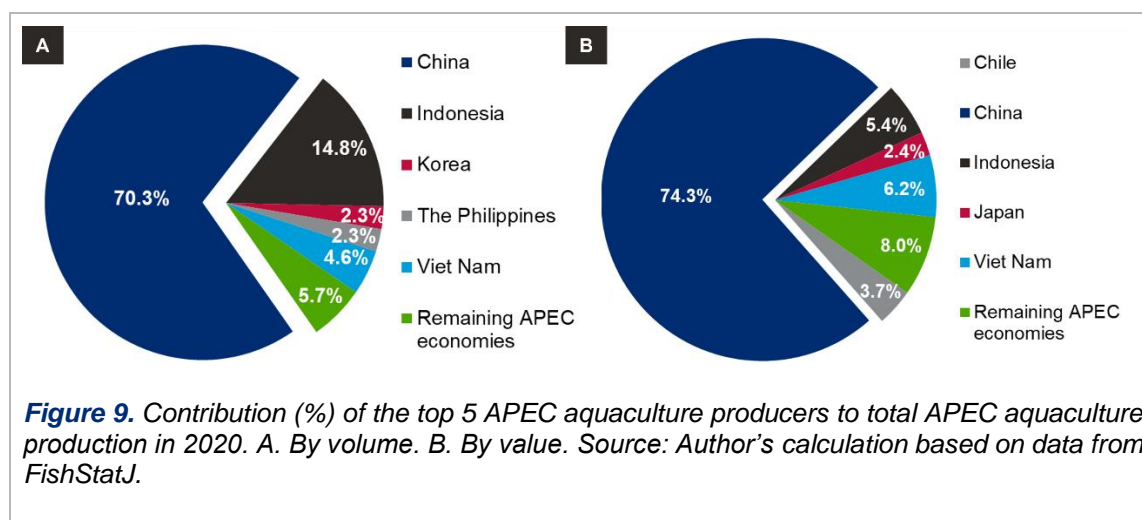
Meanwhile, the total imports of fish commodities show similar values, with an average increase of USD33 billion, or 5% annual growth. In 2015, both exports and imports experienced a disproportionate decline, reaching -9% and -8% respectively. During the first year of the pandemic, the region experienced a decrease comparable to the performance in 2015, with exports and imports decreasing by -8%. Noteworthy, this decrease followed a previous downward trend that began in 2017 and may have been exacerbated by the pandemic.

Global seafood demand rebounded strongly in 2021, adding USD13 billion of trade, driven by growing demand for high-value seafood in the US, EU, and China, as seen in demand for shrimp, salmonids, and crabs in the US (Sharma & Nikolik, 2022). The high demand for healthy and premium species is expected to continue driving trade volumes of high-value seafood in the coming years. Unprecedented high prices for many seafood commodities have been reported worldwide caused by challenges in international trade including rising freight and energy costs due to geopolitical issues in Europe and continued lockdowns in China (Sharma & Nikolik, 2022).

I.2. Socio-economic impact of the COVID-19 pandemic at the individual economy levels

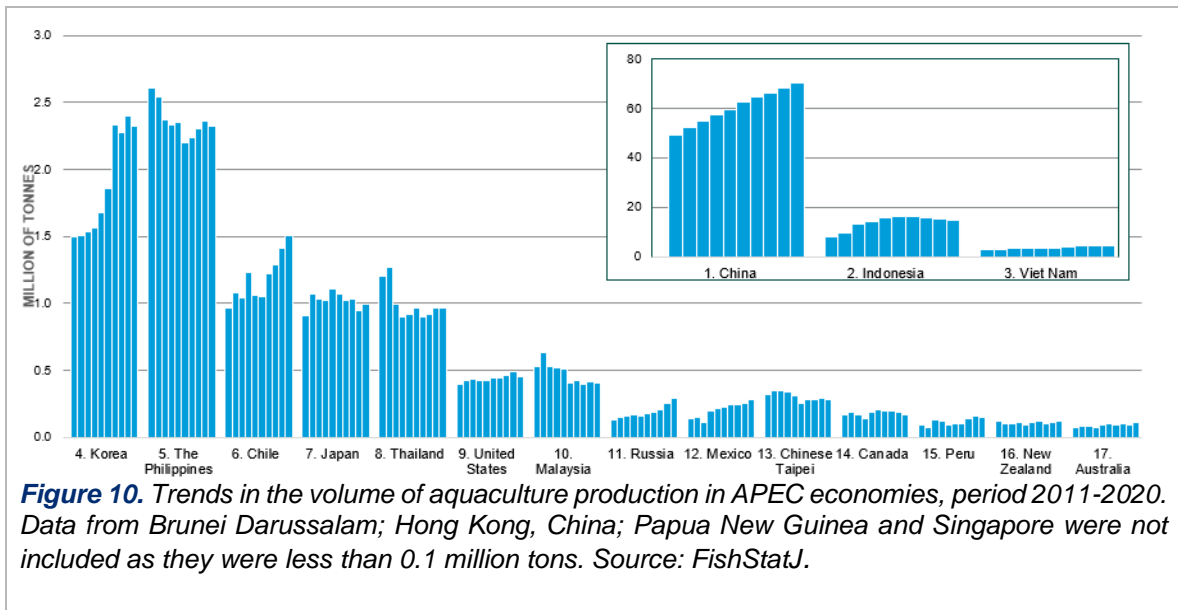
I.2.1. Productive performance

China outweighs the contribution of all other producers in the APEC region combined (Figure 9). The following top producing economies in the region in 2020 by volume were Indonesia; Viet Nam; Republic of Korea⁵ and the Philippines (Figure 9A), whereas by value they are Viet Nam; Indonesia; Chile and Japan, while the remaining APEC economies contribution combined are 8% (Figure 9B). The differences in the ranking by volume or value can be explained by the production of high commercial value species, like in the case of Chile with Atlantic salmon, Pacific salmon and rainbow trout, which increase its combined value.

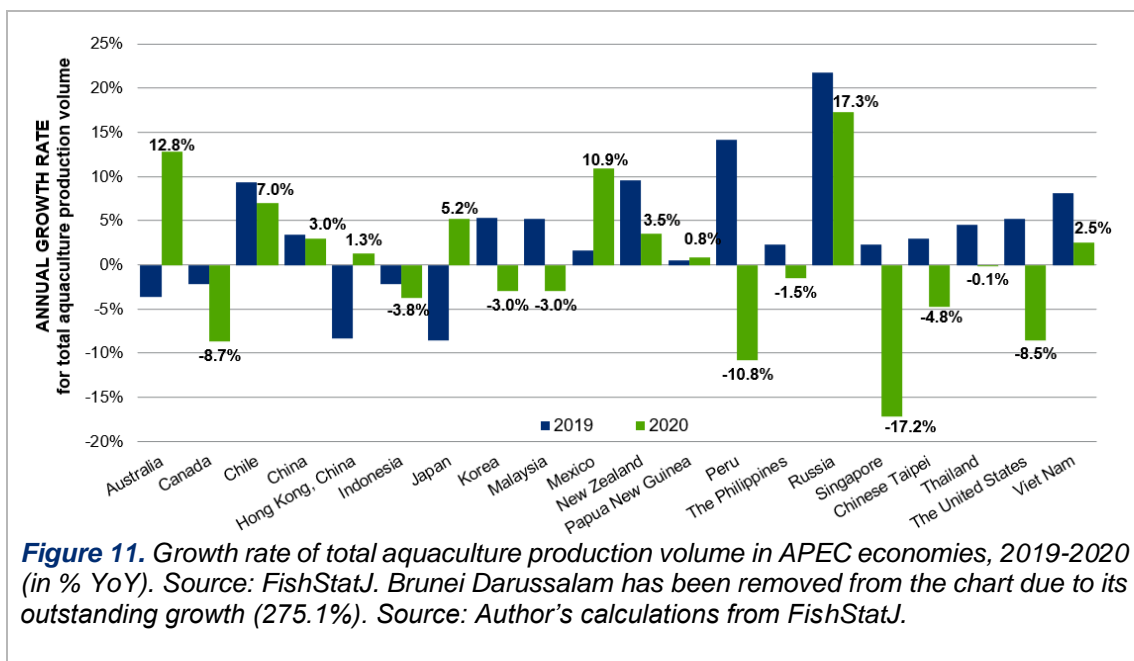


Chile is the sixth larger aquaculture producer (by volume) in the region, followed (in ranking order) by Japan; Thailand; the United States; Malaysia; Russia; Mexico; Chinese Taipei; Canada; Peru; New Zealand and Australia (Figure 10). Papua New Guinea; Singapore; Hong Kong, China, and Brunei Darussalam are the last economies in the ranking, all producing less than 0.007 million tons. The trends for the period 2011-2020 show consistent growth for Chile; China; Korea; Mexico; Russia; The United States and Viet Nam. Meanwhile, decreasing trends are observed for Indonesia; Malaysia; Chinese Taipei and Thailand. Mixed to minor variations in the past decade are documented for Australia; Canada; Japan; New Zealand; Peru and the Philippines.

⁵ Hereinafter "Korea".

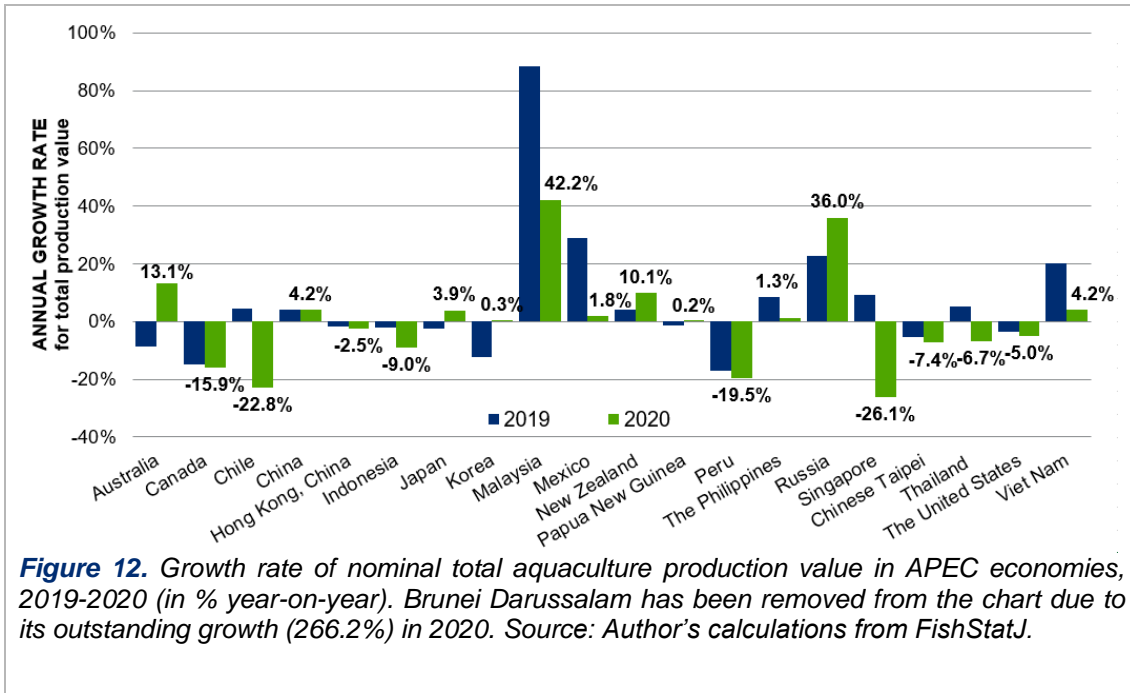


The annual variation in total aquaculture volume in 2020 was negative for nine APEC economies (43% of the region), the most affected being Singapore; Peru; Canada; the United States; Chinese Taipei; Indonesia and Korea (Figure 11). On the other hand, 12 APEC economies (57% of the region) reported growth over the same period with Brunei Darussalam (275%), Russia, Australia, Mexico, Chile and Japan having the highest variations. Brunei’s astonishing expansion is explained due to increased production of marine farm prawns and is part of the government’s drive to diversify the economy, through the expansion and optimization of existing operator sites, the opening of new aquaculture sites, and the promotion of foreign direct investment⁶.



In 2020, total aquaculture production value decreased in nine APEC economies (43% of the region): Canada; Chile; Hong Kong, China; Indonesia; Peru; Chinese Taipei; Thailand; Singapore, and the United States (Figure 12). The remaining 12 APEC economies (57% of the region) registered growth with Brunei Darussalam (266.2%) having the highest growth rate.

⁶ Borneo Bulletin. 12 November 2021. Accessed: 18 January 2023. Available in: <https://borneobulletin.com.bn/aquaculture-pitched-to-japanese-investors/>



COVID-19's impact on the aquaculture sector were felt alike in economies of different income classifications, including high-income⁷ economies such as Canada; Chile; Hong Kong, China, Singapore and the United States; upper-middle-income, such as Peru and Thailand; and lower-middle-income economies such as Indonesia. Chile's case is interesting as the value and volume growth rates contrast significantly. Although volume growth in 2020 was close to the average of the last decade 2011-2020 (8.5%), value growth (-22.8%) was on the opposite side of the decade's average (12.1%), suggesting that production could not be rescaled and that lower prices had a critical effect, with the higher production not compensating for the low market price.

The decline in the aquaculture sector (by value) corresponded to the overall performance of their respective economy (measured as annual GDP growth) for four of the most affected economies: Canada; Chile; Peru, and Thailand (Table 2). In 2020, sixteen economies (16/20) registered a decrease in total GDP, while only nine (9/21) registered a decrease in aquaculture production value, showing that the sector performed better than expected, and in some cases completely outperformed, such as those for Japan; Malaysia; Mexico; New Zealand; the Philippines and Russia.

Table 2. Comparison of annual GDP growth (%) and annual growth of aquaculture products (by volume %) in 2015 and 2020 for APEC economies.

Economy	GDP annual growth (%)			Annual growth aquaculture* (%)	
	2015	2020	2021	2015	2020
Australia	2.1	0.0	1.5	-0.8	13.1
Brunei Darussalam	-0.4	1.1	-1.6	24.8	266.2
Canada	0.7	-5.2	4.6	10.3	-15.9
Chile	2.2	-6.0	11.7	-33.4	-22.8
China	7.0	2.2	8.1	2.0	4.2
Hong Kong, China,	2.4	-6.5	6.4	-3.7	-2.5
Indonesia	4.9	-2.1	3.7	-17.0	-9.0
Japan	1.6	-4.5	1.6	-3.5	3.9
Korea	2.8	-0.9	4.0	0.2	0.3
Malaysia	5.1	-5.7	3.1	-17.4	42.2
Mexico	3.3	-8.2	4.8	1.0	1.8

⁷ Borneo Bulletin. 12 November 2021. Accessed: 18 January 2023. Available in: <https://borneobulletin.com.bn/aquaculture-pitched-to-japanese-investors/>

New Zealand	3.7	-1.3	4.7	22.2	10.1
Papua New Guinea	6.6	-3.5	1.5	-7.0	0.2
Peru	3.3	-11.0	13.4	-43.4	-19.5
the Philippines	6.4	-9.5	5.7	-3.9	1.3
Russia	-2.0	-2.7	4.8	-6.3	36.0
Singapore	3.0	-4.1	7.6	15.4	-26.1
Chinese Taipei	**	**	**	-10.7	-7.4
Thailand	3.1	-6.2	1.6	-9.2	-6.7
The United States	2.7	-3.4	5.7	3.8	-5.0
Viet Nam	7.0	2.9	2.6	12.5	4.2

Source: World Bank and FishStatJ.

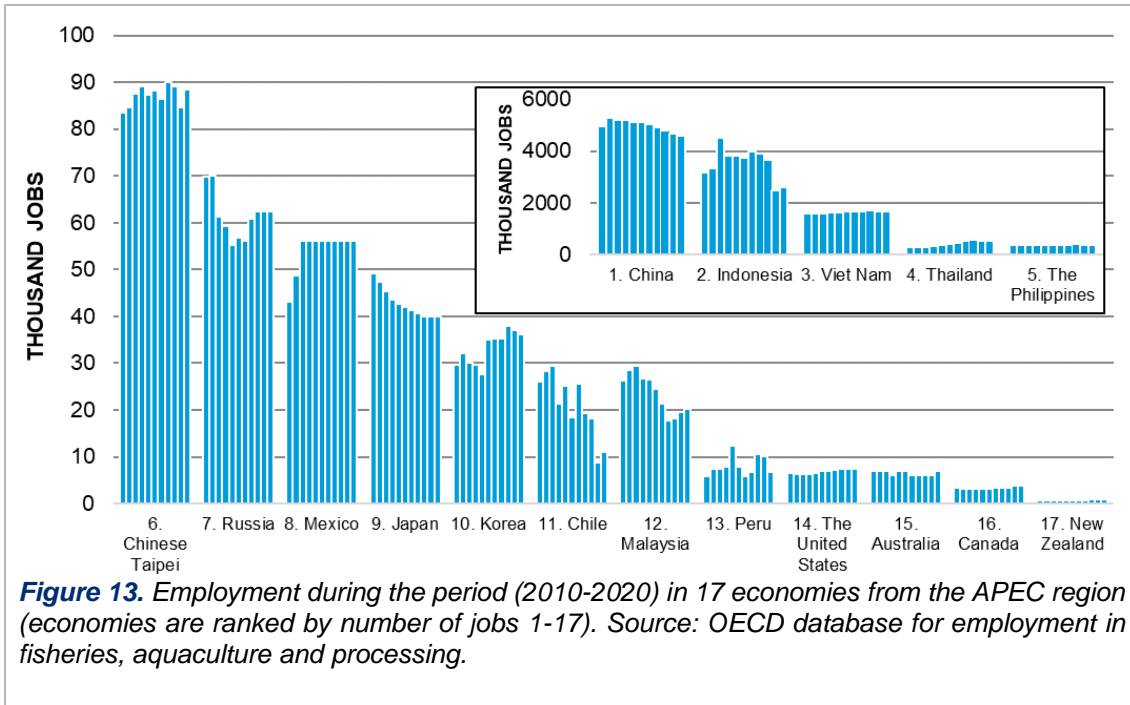
The impact of the pandemic will also ultimately depend on management responses and how the sector performs in the recovery phase (2021-2022). Official statistics on the sector for the years 2021 and 2022 will shed further light on this. Data on the performance of the aquaculture sector in 2021 are not currently available in the FishStatJ database and official government reports for APEC economies are still being developed.

During the application of the questionnaire, APEC government officials from the sector were asked about the performance of the aquaculture sector in 2021 in their economies, Australia's representative indicated approximately 10% variation, Hong Kong, China, a 4% decrease, New Zealand's representative reported values for three selected three species: Mussels (-10%), Oysters (24%) and Salmon (36%), Chinese Taipei a 1-2% of growth, Thailand a 0.69% growth and Japan a slight reduction. There are clear signs of recovery in the aquaculture sector. However, this process has not been even among APEC economies, which has implications for the type of support that each one may need.

The 2021 annual report published by the Indonesian Ministry of Marine Affairs and Fisheries (MMAF) was offered during the interview with Indonesia's interviewee. This report summarizes the growth of aquaculture production between 2020–2021, which was -13.57% for fish, 0.05% for seaweed with a total contraction for all aquaculture products of -5.33%, compared to the previous year or pre pandemic levels. During 2020, aquaculture production was significantly reduced across aquaculture commodities, excluding shrimp. However, from 2021 to 2022, aquaculture production has increased.

I.2.2. Employment performance

In general terms, a gradual and continuous decline in the number of jobs related to the aquaculture sector is observed for Chile; China; Indonesia; Japan and Malaysia over the period 2011-2020 (Figure 13). Most economies did not exhibit variation in employment generated by the aquaculture sector in 2019 and 2020, in fact only four economies reported job losses for the aquaculture in 2020: Peru with -33.5% and China; Korea and the United States with minor reductions (Table 3).



In 2020, China; Indonesia; Viet Nam; Thailand and the Philippines headed the list as those generating more employment in the aquaculture sector, encompassing nearly 97% of the employment in the region. In addition, Australia; Canada; Chile; Indonesia; Malaysia; New Zealand and Chinese Taipei created new jobs in the sector. A limitation of the OECD database is that a portion of the available data corresponded to estimates instead of official statistics (due to unreported data). The latter is the case for APEC economies such as Japan; Mexico; the Philippines; Russia; Thailand and Viet Nam.

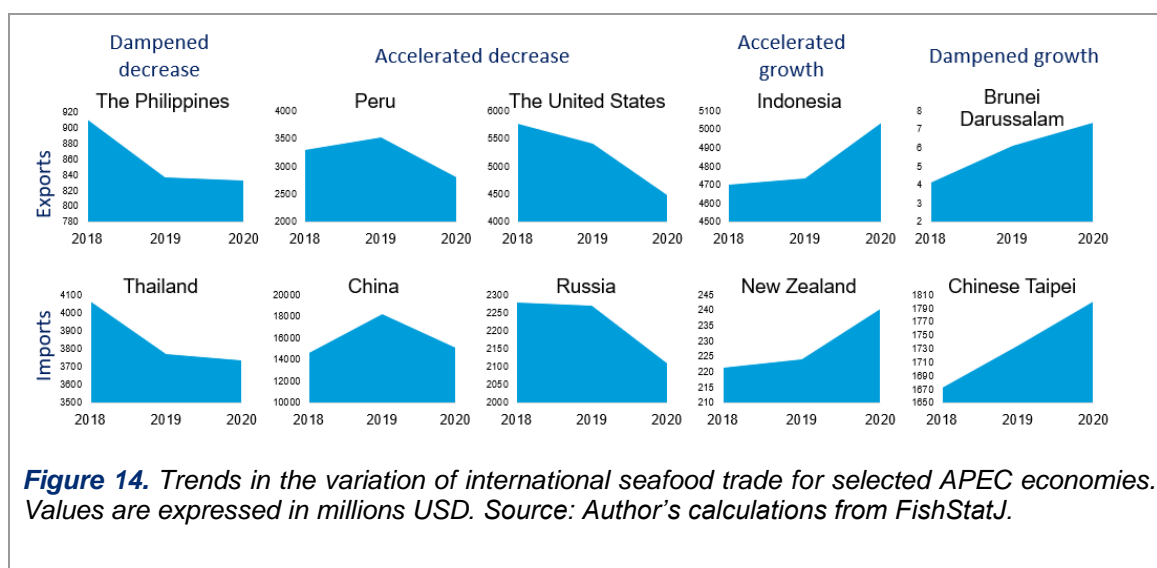
Table 3. Total employment and variation rates in the aquaculture sector in 17 APEC economies, 2011-2020.

Economy	Total 2019	Total 2020	Average variation (%) 2011-2019	Variation (%) 2018-2019	Variation (%) 2019-2020
Australia	6000	7000	0.0	0.0	16.7
Canada	3785	3934	19.5	8.0	3.9
Chile	8881	11135	-60.8	-51.5	25.4
China	4663678	4575402	-13.5	-1.7	-1.9
Indonesia	2494507	2607530	-22.0	-30.7	4.5
Japan	39928	39928	-15.7	0.0	0.0
Korea	37034	36118	12.7	-2.5	-2.5
Malaysia	19469	20262	-29.2	6.4	4.1
Mexico	56250	56250	15.5	0.0	0.0
New Zealand	840	900	45.2	0.0	7.1
Peru	10162	6755	-8.9	-3.8	-33.5
the Philippines	350000	350000	0.0	0.0	0.0
Russia*	62516	62516	-10.6	0.0	0.0
Chinese Taipei	84669	88366	89.6	-5.0	4.4
Thailand	521372	521372	18.0	0.0	0.0
The United States	7543	7344	4.5	2.8	-2.6
Viet Nam	1678960	1678960	6.5	0.0	0.0

Source: OECD database for employment in fisheries, aquaculture and processing. *Sector whether fisheries or aquaculture is unspecified.

I.2.3. Trade of fisheries commodities

For this analysis, the total international trade of seafood products in APEC economies was categorized into four patterns (accelerated growth, dampened growth, accelerated decline and dampened decline) based on the growth rates in 2018-2020, following Cai et al. (2021) methodology. Both imports and exports of most APEC members declined in 2020. For the total value of fisheries exports, 76% of APEC economies (16/21) showed accelerated decline. Two sub-patterns can be identified in this group, as some members evidenced a growing trend (e.g., Canada; Malaysia; Peru) or declining trend (e.g., China; Mexico; The United States) prior to the 2020 decline (Figure 14). Three APEC economies (14%) showed dampened decline (the Philippines; Thailand and Viet Nam). Only two APEC economies saw an increase in their seafood exports in 2020: Brunei Darussalam with a dampened growth and Indonesia with an accelerated growth.



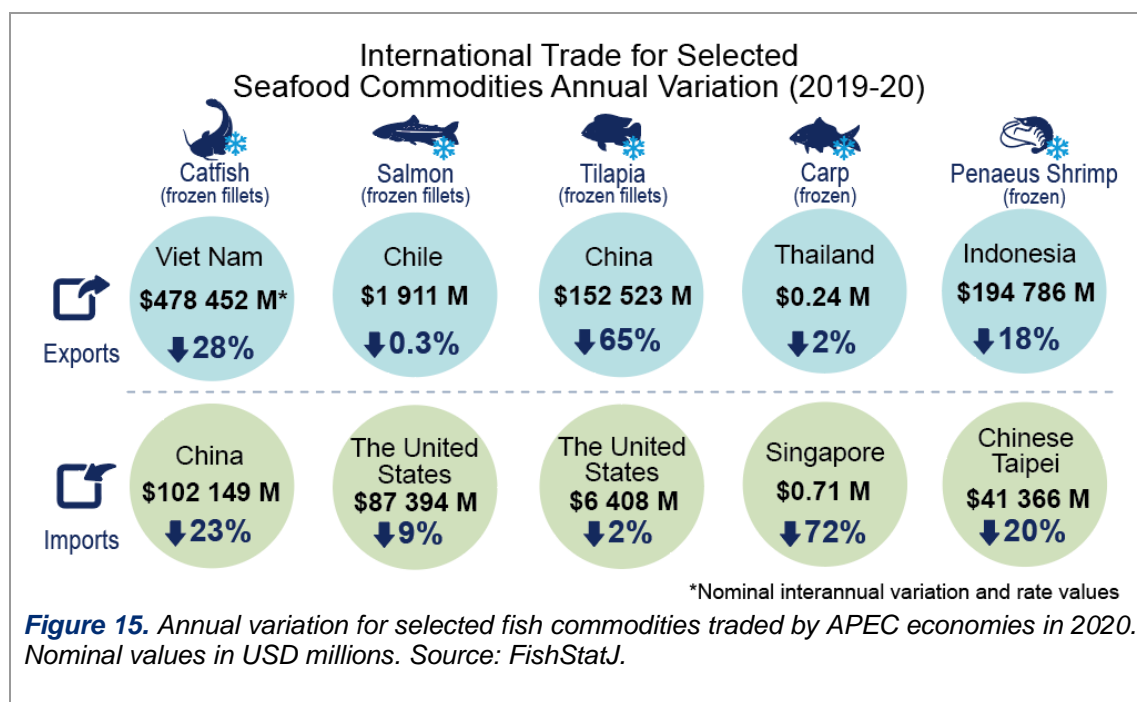
Comparing this with data from the total value of aquaculture production (Figure 12), almost half of the region saw a drop in their production value in 2020. These economies also showed declining rates of seafood exports, except for Indonesia, which showed an increase in exports growing in 2020. However, the data for seafood exports is not specific to aquaculture products, thus the evident increase of exports in Indonesia was most likely a contribution of products from capture fisheries rather than aquaculture.

Similar trends can be seen in the APEC region's seafood imports, with most economies (62%) following an accelerated decline in 2020 and 10% (2/21) categorized as in dampened decline (Korea and Thailand) (Figure 14). Six economies show an increase in total imports, only one (Chinese Taipei) shows a dampened growth, while the remaining 24% (5/21) show an accelerated growth (Chile; New Zealand; Papua New Guinea; Peru and Viet Nam).

During the workshop developed as part of the present report, Ms. Graciela Pereira, Executive Director of INFOPECA gave insights into the situation of the commerce of fishery products in 2021 and 2022. In 2021, the commerce suffered mostly from insufficiency of containers and high logistics costs. In 2022, the market and demand recovered completely, and the commerce reached new records. The total production of fishery products grew 1.2% in this year, reaching 183.2 million tons, while aquaculture grew 2.6%. The following year the total value of fishery products reached USD193 thousand million and economies such as China; Chile; Ecuador and Norway will represent most of this increase in value worldwide. Most of the impacts of COVID-19 on fisheries and aquaculture ended in 2021. Nowadays (2023), only input costs remain high. The price of freight has diminished strongly from peaks of USD9,806 in January 2022 to USD2,214 on 27 January 2023, closer to the value on 6 March 2020, USD1,356. For 2023, the fishery

commerce is expected to reach over USD193 thousand million and high inflation rates in the main importers may translate into higher prices.

Even though there are more than 622 aquaculture species worldwide, a small group of species accounts for most of the global seafood trade (FAO, 2022b; Naylor et al., 2021). Salmon and shrimp are the most traded products in terms of value, while carps are the leading group of aquaculture species in terms of volume (Ahmed & Azra, 2022; Naylor et al., 2021). Salmon, catfish and shrimp account for nearly one-third of the international seafood trade in terms of value (Naylor et al., 2021).



In 2020, APEC economies experienced large fluctuations in the trade of different fish commodities. Frozen catfish filets in Viet Nam and frozen tilapia filets in China had large fluctuations in 2020 compared to 2019, while frozen salmon filets in Chile and frozen carp in Thailand had minimal annual fluctuations (Figure 15). Indonesia, the largest shrimp exporter, experienced a 18% decline. This negative trend for the major exporters was mostly correlated with a varying decrease in imports, which is the case for China; Singapore and Chinese Taipei, with frozen catfish filets, frozen carp and frozen Penaeus shrimp, respectively. The main importers of frozen tilapia and salmon filets experienced a more gradual decline but comparable in terms of value.



II. SECTION 2: MAJOR DISRUPTIONS FROM COVID-19 TO THE AQUACULTURE SECTOR IN APEC ECONOMIES

Key messages:

- » There is a need to develop micro-regional and economy-wide studies on the recovery process of the aquaculture sector after the pandemic (2021 and 2022 data).
- » Signs of recovery have been present since 2021.
- » The first major disruption caused by the pandemic was related to labor.
- » Employment and production expenses in the processing sector were hit the hardest.
- » The most vulnerable groups to the effects of the pandemic in both the primary and secondary aquaculture industries were migrant workers, ethnic minorities, gleaners and vendors, especially women.
- » The transport/logistics and market stages of the AVC were the most affected.
- » The decrease in demand and increase in production costs were among the main effects of the pandemic on aquaculture activities.
- » The impact of the pandemic was uneven across APEC economies and production systems, even within the same economy.
- » Aquatic food consumption declined heavily in the initial stages of the pandemic.
- » The consumption of local and processed seafood has increased.
- » Digital sales and expansion of e-commerce were among the most used tools by fish farmers to access new markets.

This section details the general disturbances observed in AVC worldwide during and after the pandemic and highlights the specific challenges faced in APEC economies. Key findings from available scientific studies and information obtained from the interviews are presented as case studies. Most of the currently available information documents the impacts during the first year of the pandemic and during the lockdown periods in early 2020, while less is known about the adaptation and recovery phases in 2021 and 2022. This highlights the need for **global and regional studies and census on the recovery process of the sector in the post pandemic scenario** with participation of all major aquaculture stakeholders. Although most of the reviewed documents listed impacts and responses, data on governments responses are provided in the following section ([Section 3](#)).

II.1. Origin and classification of COVID-19 major disruptions

Most of the disruptions in the sector were not caused by COVID-19 itself, but instead they were highly dependent on the severity of the restrictions imposed by governments to control it (Rendón et al., 2021). Restrictive measures severely disrupted both the primary and secondary sectors, mostly through impact on the transport/logistics and the market stages, and up to the level of paralyzing fish production or severely reducing aquaculture practices, exposing weaknesses and vulnerabilities in the sector. The effects of the pandemic were felt by SSA farmers even in regions where no COVID-19 infections were registered, as seen in surveys applied to fish, crab, and shrimp small-scale farmers in Thailand (Chumchuen et al., 2022).

The pandemic triggered cascade effects, which for the purposes of the present report are grouped into six main areas (See box to the left), although there are complex interrelationships between them, and they have occurred in parallel. Conversely, COVID-19 has also created new opportunities (See box below), also covered in this document.

COVID-19 MAJOR DISRUPTIONS

1. Labor disruptions
2. Supply chain and production disruptions
3. Market demand and price disruptions
4. Financial disruptions
5. Disruptions on seafood consumption
6. Exacerbation of sex and gender inequality

Effects were more pronounced during the restrictive period in 2020, than 2021 (Belton et al., 2021). WorldFish applied surveys in five major aquaculture producing regions in Africa, Asia, and the Middle East in early 2021, and found signs of recovery after the pandemic. Many individuals stayed in business, while an increase in labor and better access to inputs was perceived. Sales performances were mixed and respondents in some but not all economies had better access to buyers in 2020 than 2021 showing that a complete recovery may take more time (Love et al., 2022).

Aquaculture in APEC economies has apparently overcome most of the impact of the pandemic in macroeconomic terms, however in microeconomic terms, some small-scale farmers may still be experiencing difficulties. Situation in Thailand was described during the interviews as follows: *“During 2021 most of the aquaculture had recovered to near pre-pandemic levels, fish farmers have produced more this year and the regulations were lifted”*, similar opinions were shared by representatives from other APEC economies as Chile and Mexico.

COVID-19 OPPORTUNITIES

1. Expansion of direct sales
2. Expansion of local markets and demand for local seafood
3. Expansion of e-commerce
4. Increased expansion of e-governance
5. Increased demand for non-perishable seafood inequality

II.2. Vulnerable groups

SSA was particularly vulnerable to the economic shock caused by COVID-19 due to informality, unpredictable sources of income, lack of access to finances, social protection and government support (FAO, 2021a; Love et al., 2022). Though the perception of this may vary between economies and policymakers. During the questionnaire, representatives from New Zealand; Peru and Thailand indicated that SSA was considered to be relatively more affected by the pandemic. Representatives from Australia and Chinese Taipei felt that the SSA of their economy was not the most affected. This was mainly explained by the fact that, for example, *“small scale aquaculture does not have a significant presence in Australia”*. Hong Kong, China, and Japan representatives were not sure about this assertion.

Most small-scale fishers and fish farmers did not have any livelihood strategies to cope with stressors/shocks beyond short-term saving as seen in Viet Nam (Rendón et al., 2021). On the other hand, seafood supply chains of larger companies with electronic traceability data had

access to real-time information on market shifts and cold storage constraints, allowing for timely business and government interventions. For example, in Indonesia, the eLogbook system and post-harvest data made it possible to understand supply chain bottlenecks, including cold storage shortages, transportation limitations, and processing facility closures (Maruff, 2020). Fisheries and aquaculture producers exporting live or fresh products were more vulnerable, as well as were producers in low- and middle-income economies compared to high-income economies (Love et al., 2022; Maruff, 2020).

The effects were mixed for different production systems, even those located within the same economy. The shrimp sector in Viet Nam weathered the crisis (2020-2021), better than the catfish sector, the two main aquaculture species farmed in Viet Nam⁸. In China, the catfish industry was comparatively more affected than the tilapia sector in the first year of the pandemic (Yuan et al., 2022) (See Box 1), while shellfish farms saw moderate impact (Zhang et al., 2021). Shellfish aquaculture has characteristics that can explain its resilience to the impact of the pandemic. Ma Junemie Hazel Lebata-Ramos, scientist from the Aquaculture Department in SEAFDEC shared her insights into the situation of the mollusks industry during the pandemic.

“Mollusk culture was not much affected during the pandemic, especially the two most important mollusk species produced in the Philippines, the oysters and mussels. These are non-fed species, and the seed stocks are from the wild. Culture begins with the settlement of competent larvae on available clutches and continued until they reached harvestable size, were harvested, and sold. Farmers' hands-on involvement is required only during spawning, harvesting and marketing. Although marketing was affected due to the lack of transportation, the farmers can leave them untouched in the cultural areas until the condition becomes favorable and the situation is normal. Prolonging the culture doesn't entail additional costs since no feed is needed and it provides the farmer, his family and his community with a source of food”

Box 1. The impact of COVID-19 on aquaculture in China and recommended strategies for mitigating the impact (Yuan et al., 2022).



⁸ MARD, Viet Nam Customs. Accessed: 18 January 2023. Available in: https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Grain%20and%20Feed%20Annual_Hanoi_Vietnam_VM2022-0026.pdf

II.3. Labor disruptions

II.3.1. Labor was the most immediate disruption

Mobilizing workers during the pandemic was logistically challenging due to lockdowns, transportation restrictions, physical distancing in the workplace, illnesses, a 14-day quarantine process, and travel barriers for seasonal or migrant workers. Several jobs in the sector were lost in the period, for example Peru experienced a 33.5% drop in the number of jobs from the aquaculture sector ([See Section I.2.2 Employment performance](#)).

Some aquaculture companies in China delayed the resumption of work because employees who had returned to their hometowns to celebrate the Chinese New Year were unable to return to work due to the lockdown (Zhang et al., 2021). Rotating shift systems, quarantines and absenteeism due to illness, were among the main causes of reduced available labor in aquaculture farms during this period, as seen in the Chilean salmon industry (Box 2).

Box 2. Impact of COVID-19 on the Chilean salmon industry.

Information comes from Lorena et al. (2022) and interview with Dr. Alicia Gallardo Lagnos. When asked about the impact of COVID-19 on the salmon industry in Chile, the former director of SERNAPESCA explained:

“Chilean salmon farming exports to more than 120 economies, many shipments go through the airport in Santiago, which are fast shipments of fresh salmon, and others go through Argentina and also by sea. The first route that was affected in the salmon industry was the logistics of shipments for export, due to quarantine restrictions. In Chile, quarantines were carried out by geographical area and salmon farming is located in the three most southern regions. Another problem was related to services for salmon farming, feed, vaccines, treatments, etc. The government rapidly listed the essential activities for the population, to which aquaculture producers were later added, by means of a safe pass that they had to apply for. In some cases, the delay of this meant a problem with the health condition of the animals. If you look at the analysis of antibiotics, there was a period when the consumption of antibiotics increased, probably because there was no logistics for health management, which was quickly recovered”.

The extent of the impact of market restrictions on the salmon industry was detailed:

“China was the first to restrict the export of salmon because they began to analyze the product. At customs they found a positive PCR which meant that the processing plant (registered in the Biobio region) was restricted. It was at the beginning of the pandemic, we immediately conducted a remote inspection, with great effort and support from the Chinese ambassador and customs, the plant was removed from the export restriction”.

When enquired about the current state of the Chilean aquaculture industry and the recovery process Ms. Gallardo stated: *“has already recovered, the two types of aquaculture are already with positive numbers and they are already exporting to other markets, even expanding the range of markets”.*

Moreover, Lorena et al. (2022) gives insights into the main difficulties perceived by the industry:



CHILE

Digital survey to 52 individuals with highest position in the salmon industry. Region with 99% of the national production (Los Lagos, Biobío, Aysen & Magallanes). Most of them from processing plants and grow out areas. Period: November 2020 to April 2021.



74%

...indicate a decrease in production.

Attributable to...



40%

Rotating shift system

38%

Quarantines

33%

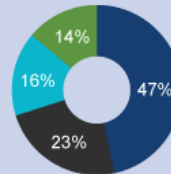
Absenteeism due to illness



79%

...perceived a decrease in sales.

Caused by...



■ Decreased demand

■ Closure of markets

■ Price variation

■ Other

SSA is labor-intensive, making it more vulnerable to restrictions on the movement of workers and disruptions in the supply of input and transportation. However, this is not a rule of thumb, in Japan, it was observed that corporate businesses in the fisheries and aquaculture sector appeared slightly more vulnerable to the spread of COVID-19 than family-run enterprises, although more vulnerable than small-scale fishing operations (Sugimoto et al., 2022).

Some aquaculture farmers had to replace their permanent staff with seasonal workers or engage their family members to reduce farm production costs, which impacted the time of active fish surveillance (Manlosa et al., 2021; Salajegheh et al., 2022). As pointed out during the interviews: *“In other cases, there were also problems due to lack of surveillance in cages, the deficient surveillance generated robberies, among other direct impacts”* as notified by interviewees from Mexico and Peru.

Although labor disruptions were considered the main problem during the pandemic for many economic sectors, labor-related issues were among the less common perceived impacts by aquaculture farmers in Malaysia and for about 50% of the respondents, reducing the number of employees was the last option to be chosen (Azra et al., 2021). Similarly in Thailand, 50% of respondents to a survey reported developing activities normally and for around 50% of respondent’s production quantity was not affected, while up to 90% reported reduced price of fish and reduced revenues as the main effect, and 50-70% noticed reduction in marketing channels (Chumchuen et al., 2022). This study was developed in an area with low COVID-19 cases among the general population showing that the effects varied between regions.

II.3.2. Comparison of labor disruptions in fisheries, aquaculture and seafood processing plants

It has been suggested that compared to capture fisheries, the primary aquaculture sector had lower infection rates during the pandemic because fish farm operators and workers are relatively stationary compared to capture fisheries which are characterized by the migratory nature of the fishing activities. Nevertheless, **the secondary sector (seafood processing plants)**, which usually employs a large number of workers, **experienced the most severe labor disruptions during the pandemic.**

OECD data show that the seafood processing sectors in Australia; Chile; Peru and the United States experienced a reduction in the number of jobs created (Table 4). The variation was higher than the aquaculture sector (primary sector) in all economies except for Peru, which was hit the hardest in the aquaculture sector. Employment in the fisheries sector is highly seasonal and comparing job creation over several years is not feasible without considering other factors such

as natural disasters, environmental issues or details of import demand from the major export markets in those years.

Table 4. Employment variation in fisheries, aquaculture and seafood processing sectors in selected APEC economies, 2018-2020.

Economy	Sector	2018	2019	2020	Variation 2019-2020
Australia	Aquaculture	3505	3785	3934	3.9
	Fishing Sector	45933	51381	49074	-4.5
	Processing	21602	21433	19716	-8.0
Chile	Aquaculture	18315	8881	11135	25.4
	Fishing Sector	37249	34973	32978	-5.7
	Processing	61794	41501	40537	-2.3
Indonesia	Aquaculture	3600854	2494507	2607530	4.5
	Fishing Sector	2637269	2736218	2437787	-10.9
	Processing	61064	62866	78126	24.3
Korea	Aquaculture	37995	37034	36118	-2.5
	Fishing Sector	90728	88535	85434	-3.5
	Processing	38064	37921	43167	13.8
New Zealand	Aquaculture	840	840	900	7.1
	Fishing Sector	2602	2601	2688	3.3
	Processing	5150	5150	5150	0.0
Peru	Aquaculture	10562	10162	6755	-33.5
	Fishing Sector	83542	84976	68010	-20.0
	Processing	41587	39761	31707	-20.3
The United States	Aquaculture	7334	7543	7344	-2.6
	Fishing Sector	158811	164522	164616	0.1
	Processing	34597	35406	32298	-8.8

Source: OECD database on Employment in fisheries, aquaculture and processing. Data based on estimates was not included.

At the production stage, seasonal workers needed for harvesting, transportation, and other services were hired less due to the declining in production, with significant negative consequences for many workers who were dependent on these activities (Mangano et al., 2022). Fish and seafood processing sectors are generally less automated than other food processing subsectors and were therefore among the most vulnerable food supply chains (Hailu, 2021). The fish processing sector also experienced shortages of raw materials in some cases, resulting in seasonal workers not being hired during this period.

II.3.3. Informality and labor disruptions in SSA

Many workers in the aquaculture sector in developing economies operate in the informal sector without social insurance coverage and COVID-19 caught them unprotected. These individuals are usually self-employed, do not have a written contract, and/or are paid less than the legal minimum wage. This group includes small-scale farmers, migrant workers, ethnic minorities, harvesters, gleaners, and vendors, especially women, who have been among the hardest hit by the pandemic (FAO, 2021a). Mr. Alejandro Flores Nava, Principal Officer of Fisheries and Aquaculture for Latin America and the Caribbean from FAO, described the situation of informality in the Latin American aquaculture sector, which may apply to developing economies in Asia.

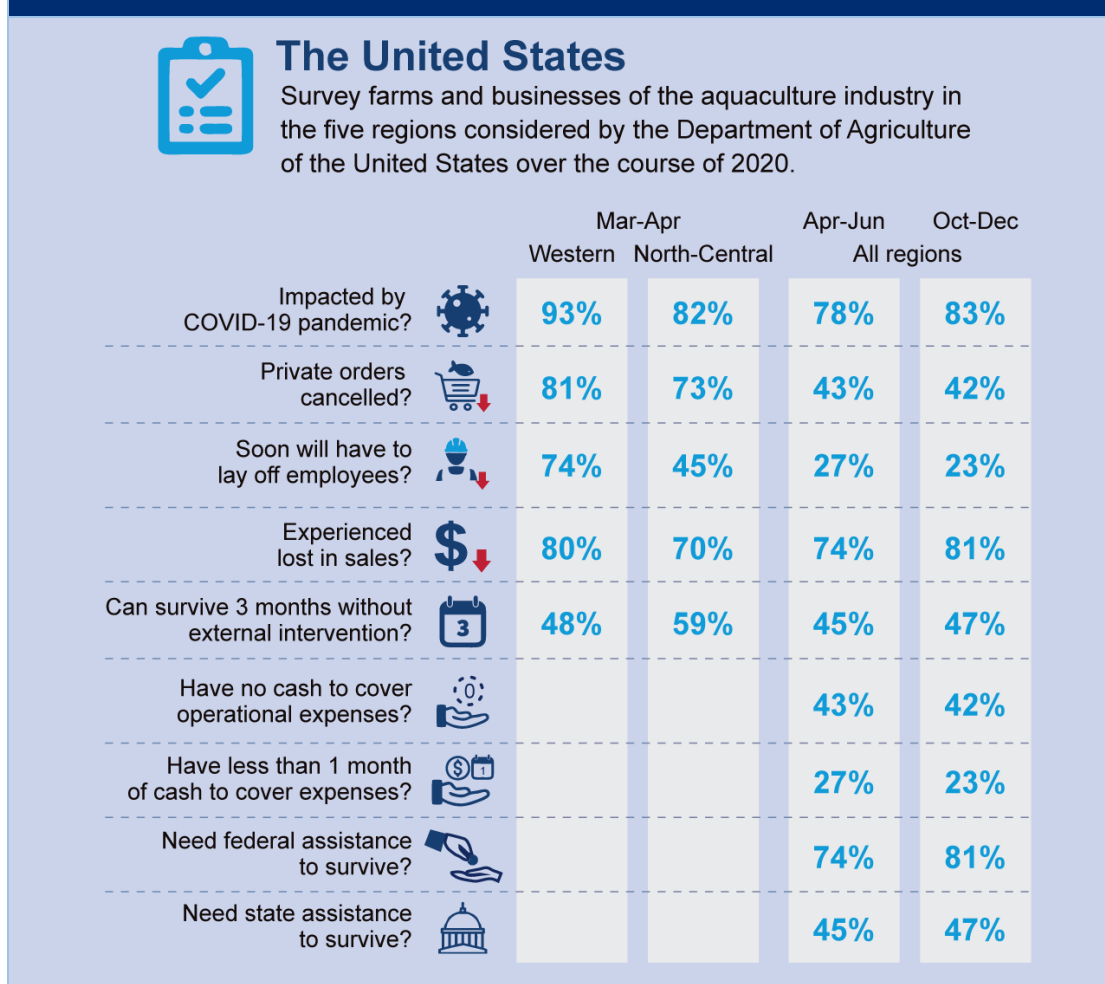
“Many are in the informal sector because they are geographically dispersed, the state does not reach where they are and therefore, they do not participate in government programs, they are isolated, but they are still producers and have an impact on the economy of the community. A census is important, it is necessary to know how many there are, where they are and in what situation they are. This informality is sometimes due to geography, but also to ignorance, many believe that they will be charged, or that they will have a fiscal impact”

II.4. Supply chain and production disruptions

The availability of different aquaculture inputs essential to production (seed, feed, medicines, fertilizers) has been affected by border closures or lockdowns; restrictions on cargo movements; restrictions on exports and increases in transportation costs related to COVID-19 (Jamwal & Phulia, 2021; Love et al., 2022). For example, in Indonesia the logistics cost in the fisheries sector was reported to increase by 40% in 2020 (Robins et al., 2020).

This led to an increase in the cost of most inputs (Salajegheh et al., 2022). In the US, several private orders were cancelled by up to 81% (Box 3). A global survey found that **the main causal factors for supply chain disruption in aquaculture were shortages and higher prices of raw materials at the hatchery stage, lack of storage infrastructure at the production stage, and transportation disruptions at the distribution stage** (Mangano et al., 2022). Most disruptions in access to aquaculture inputs were relatively short-lived, allowing recovery after the strictest lockdown measures were eased (Belton et al., 2021).

Box 3. Impact of COVID-19 on the aquaculture, aquaponics and allied businesses in the aquaculture industry of the United States (van Senten et al., 2020; van Senten, Engle, et al., 2021; van Senten, Smith, et al., 2021).



In general, **supply chains dominated by SMEs were more vulnerable to COVID-19**, with informal supply chains facing the greater impact due to lack of formal contractual relationships, no established cold chain or access to financial services such as savings, credits or insurance. Poor access to cold chain infrastructure and subsequent degraded fish quality particularly affected small-scale fishers and aquaculture producers, since fish products could not be properly stored until new markets were found, especially in rural areas, as seen in Indonesia (Robins et al., 2020).

II.4.1. Fish stocking

Fingerlings and fish are highly perishable, making **aquaculture highly vulnerable to disruption in transportation services**. During the first waves of COVID-19, aquaculture producers were unable to sell their products and had to stockpile large quantities of live fish, increasing production costs. In addition, holding ready-to-sale fish fry or post-larvae shrimp for extended periods of time increases the risk of mortality, and allowing fish to grow larger may have created challenges in processing and marketing certain product forms, potentially resulting in lower selling prices. Expanding the operational capacity of the fish farm without adequate resources can also lead to inadequate feeding, slow growth, risk of disease outbreaks, limited storage capacity at processing facilities and limited waste management capacity. Disposal of animal carcasses has been compromised during this period, posing a biosecurity risk with environmental impacts (Salajegheh et al., 2022). Hence, **risk assessment and clear communication channels between the industry and aquatic animal health organizations were needed**.

An important strategy for resilience identified would be to develop fry production at regional and economy-wide levels to reduce the current high dependence on imported fry (Manlosa et al., 2021). In this regard, during the interviews Mr. Navas recommended the following:

“We must give a push to artisanal aquaculture, which is not given attention. Governments have research centers that could be poles for the development and monitoring of aquaculture. In Ecuador, for example, subsidized fingerlings are offered, where initial stocks are sold at a lower price. It is important that these centers are aligned with the institutional framework and health elements”

Due to the characteristics of the AVC, adapting to changes in demand can be challenging due to the propagation of the disruption upstream and downstream of the value chain. Disruptions in the production of seed will manifest as disruptions in the supply of final products in the coming weeks or months, depending on the duration of the production cycle for the species. In China, according to the traditional management of the aquaculture businesses, the post-Chinese Spring Festival period (January–February) is a critical time to clean, disinfect and prepare fishponds and aquafarms. However, since aquatic products could not be sold in time during early 2020, this resulted in overstock of aquatic products and rendered it impractical for many to begin a new cycle (Chang et al., 2022).

II.4.2. Other production inputs

Challenges with other production inputs such as feed, chemicals, fertilizers, therapeutics, growth hormones, lime, or probiotics were reported worldwide. In most Asian aquaculture economies, feed is usually manufactured domestically while some feed ingredients are imported. In Peru, the world largest producer of fishmeal and one of the largest fish oil producers, the industry was shut down due to lockdowns, causing a major disruption to the aquaculture sector in China, which is highly dependent on such imports. The situation improved in 2021 with exports of fishmeal rising to 1.22 million tons, from 856,000 tons in 2020, whilst exports of fish oil soared from 129,000 tons to 225,000 (FAO, 2022c).

Farmers had to spend a large amount of money on fish feed. During the first COVID-19 wave in Viet Nam, sales from aquaculture producers were delayed for 3 months and farmers still had to buy fish food during this time (Rendón et al., 2021). In this regard, **the production and use of locally available feeds was an important resilience mechanism** in some aquaculture supply chains that allowed them to navigate successfully through the crisis (Manlosa et al., 2021). This can be further strengthened by supporting local feed producers to mobilize and collectively formulate an action plan for similarly disruptive scenarios. In general terms, there are major advantages of **promoting local input sourcing**.

At the beginning of the pandemic, a severe shortage of life saving medical oxygen also reduced the availability to other non-health sectors, with some economies even banning its use in other sectors. Liquid oxygen is used in aquaculture to transport live fish (whether for seed transportation or ornamental purposes) to increase availability of dissolved oxygen as well as elimination of

carbon dioxide and ammonia that accumulates during fish transport, which causes stress and related mortalities (Rajts & Shelley, 2020).

II.5. Market demand and price disruptions

II.5.1. Drop in foreign demand

The closure of sales outlet markets, and distribution channels caused a significant drop in demand, instability in market prices, and reduced production volumes for most seafood products. **The logistics/transport and marketing were the most affected stages of** the AQV of APEC economies as seen in Malaysia (Azra et al., 2021); Thailand (Chumchuen et al., 2022) and Viet Nam (Lebel et al., 2021), due to transportation bottlenecks, farmers' inability to access markets, and lower demand and prices. Significant reduction in demand from major fish importers such as the US, the EU and China affected global seafood trade. For example, from January to September 2020, the total value of fish imports in China fell by 15.11% year-on-year, while the value of fish exports fell by 15.42% (Y. Zhang et al., 2021).

II.5.2. Decrease in local demand

Local demand was severely reduced by **the closing of the hotels, restaurant and catering (HORECA) sector**, which accounts for a significant proportion of fish consumption in many economies. The closure of HORECA and the cancellation of events led to an initial sharp drop in local demand for aquaculture products, particularly for high-value products such as lobsters and oysters (OECD, 2021). The initial sharp drop in demand for fresh fish products was later accompanied by an increase in demand for canned, frozen and processed fish, driven by consumer stockpiling (Havice et al., 2020). The combined decline in foreign and local demand forced fish farmers who could not sell their product to adopt different coping strategies. As a result, some decided to stockpile large quantities of live fish, raising expenses and expenditures and risks. The vulnerability and complexity of the AVC made the operations loss-making, and many producers had to discard their products within weeks.

II.5.3. Recovery of the demand after most restrictions were eased

Demand for seafood products recovered strongly in 2021 and 2022 in most economies, as COVID-19 pandemic restrictions were lifted. However, the Chinese seafood market has recently shown signs of weakening due to the Zero-Covid policy with recurrent restrictions. Data from local markets in China show that seafood sales in September 2022 decreased by 19.6% compared to September 2021, the average seafood price decreased 12.1% compared to the same period last year, while the volume of freshwater seafood sold fell by 16.5%⁹. The trend of the Chinese market in the coming time is unpredictable and will depend on the performance of the adjustments in the Zero Covid policy.

II.5.4. Volatility in fish commodities prices

The volatile market system led to **sudden massive price drops of most fish commodities** as seen with detail in a study in Japan (Box 4), **while others increased in price**. Specific data on the prices of aquaculture products can be difficult to obtain since data are often combined with capture fisheries, particularly for marine species, although information for classic aquaculture species such as tilapia, catfish, carps, salmon and shrimp provide insight into the uneven impact among products. In China, the market prices of several marine species experience a significant decline from January to April 2020, however remained stable in the later period of 2020, indicating that the adopted policies were effective¹⁰. In the Philippines, the prices for various types of fish species from capture fisheries did not decline as much as high-value aquaculture products because they were regularly consumed by local people (Manlosa et al., 2021).

⁹ Viet Nam Seafood. Restricted by Covid, the Chinese market still attracts 160 Viet Nam pangasius exporters. Accessed: 17 January 2023. Available in: <https://himex.vn/en/restricted-by-covid-the-chinese-market-still-attracts-160-vietnam-pangasius-exporters/>

¹⁰ Zhengyong Yang. The impacts of Covid-19 on fisheries and aquaculture in East Asia. Accessed: 17 January 2023. Available in: <https://www.fao.org/3/cb2362en/cb2362en.pdf>

Box 4. The COVID-19 impacts and challenges to achieving sustainability in Japan's fisheries and aquaculture (Kobayashi, 2022).



JAPAN

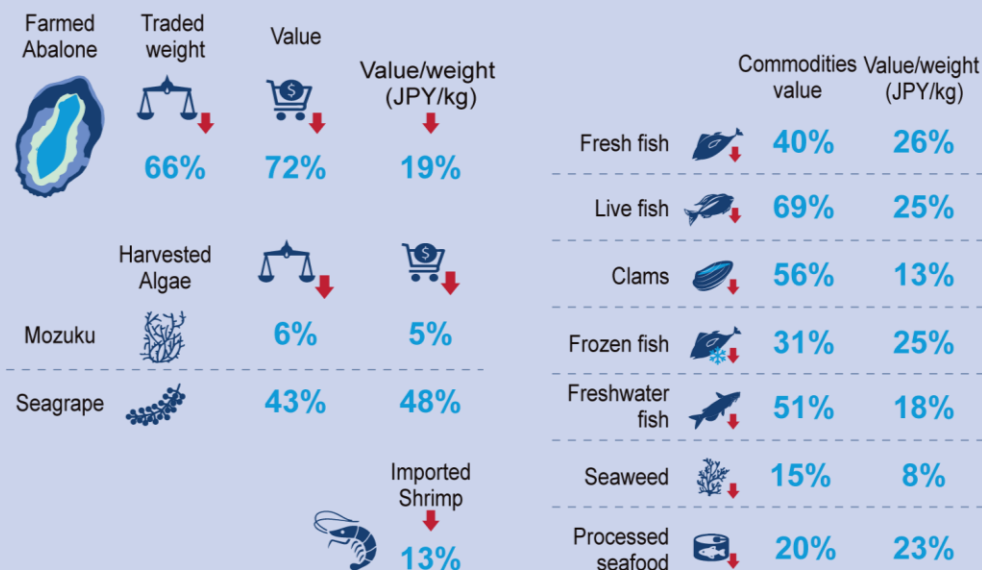
Analysis of data available from regional seafood markets (2019-20), or provided by the government, and phone interviews from April to November 2020.



Rate of change (2019-2020)
for seafood commodities



Rate of change (2019-2020)
for products relevant to tourism



The prices of low-cost products such as tilapia (freshwater fish widely consumed) were not as affected, and prices have picked up ever since. Similarly, the price of farmed milkfish was not significantly reduced in the Philippines since it is commonly consumed by locals, compared to prawns that are mostly exported and saw price drop up to 50% (Manlosa et al., 2021). The prices of grass carp, Prussian carp, and Amur carp in China, important local fish products, remained stable before COVID-19, but increased significantly after it, reaching the highest point in the second half of 2021 (Wang et al., 2023). Surprisingly, the demand for farmed Atlantic salmon has proven quite robust (Love et al., 2021), due to its highly diversified global market and multiple commercialized forms through both food service (HORECA) and retail (FAO & WorldFish, 2021).

II.6. Financial disruptions

The COVID-19 pandemic increased financial risks at all stages of the AVC, including difficulties in obtaining insurance coverage, reduced cash flows, liquidity and incomes, business losses, reduced capacity to repay loans and meet financial obligations to suppliers, and bankruptcies, which have been a major source of financial instability, as farmers can only produce if they have access to finance (FAO, 2020e). The increase in the cost of and access to production inputs has been a major cause of decline in productivity. The implementation of health measures and the distribution of PPE reduced production capacity due to increased costs, issues that may have been more pronounced in the processing sector. The vulnerability of the aquaculture sector to this type of crisis was clearly demonstrated and risk management plans should be in place to deal with future crises or disasters.

Studies on stakeholder's perception are crucial to defining coping strategies for the aquaculture industry and **will be key to developing transformations and resilience for the**

sector (Mangano et al., 2022). In the US, several surveys developed by the Virginia AREC made it possible to map the economic impact of the pandemic during each quarter of 2020 and even the percentage of aquaculture farmers benefiting from government support across the US (van Senten et al., 2020; van Senten, Smith, et al., 2021; van Senten, Engle, et al., 2021b) ([See Box 3](#)). Aquaculture farmers from the US reported lost sales to domestic markets, cancellations of private contracts, cancellations of government contracts and lost sales to international export markets (van Senten et al., 2021).

In order to know the status of the aquaculture sector in the post-pandemic scenario, APEC economies must develop such tools. There is an urgent need to develop census and studies, particularly to know the situation of the SSA farmers and develop policies accordingly. Among the best actions to increase resilience and sustainability in the aquaculture sector PhD. Alejandro Flores Nava suggested:

“In order to act, it is important to have updated information, it is necessary to carry out analyses at the micro-regional level, the needs are different. I recommend performing a diagnosis of the vulnerability of aquaculture to the effects of climate change, as a baseline for the design of an economy-wide adaptation strategy. The vulnerability of the sector may vary from region to region. Information, on the one hand, and then the design of strategies, in the case of climate change, adaptation, and in the case of unforeseen external shocks, protocols that allow, as much as possible, to have an immediate response capacity to avoid the suspension of activities that has been so harmful to many producers”

Economic losses in the aquaculture sector have varied widely worldwide (Mangano et al., 2022). In the Chilean salmon industry, up to 71% of stakeholders reported the increase in productive costs as the main challenge during the first stage of the pandemic, while a decrease in sales was the fourth most significant challenge for up to 37% of respondents (Lorena et al., 2022). In South Asia, up to 82% of farmers reported lower net income than expected and 7% exited the aquaculture business due to COVID-19 (Lebel et al., 2021). Small farmers were more likely to experience a reduction in net income and farmers with debt repayment problems were more likely to exit, while those who used savings, borrowed money, or sought new markets less likely to exit. Additionally, semi-intensive farms were more likely to exit than subsistence farms and pond farms less likely to exit than cage ones (Lebel et al., 2021). In Japan, an economy-wide online survey ran from 29 May 2020 to 18 October 2020, found that all aquaculture stakeholders surveyed reported a large to moderate decrease in total annual sales in 2020 and nearly half of them experienced changes of more than 50% from the previous year (Sugimoto et al., 2022).

II.7. Impacts on seafood consumption

II.7.1. Initial decrease in seafood consumption

Global consumption of aquatic foods has increased at an average annual rate of 3% since 1961, almost twice the population growth rate of 1.6% (FAO, 2022a). In 2020, worldwide seafood consumption, as calculated by FAO, slightly declined from 20.5kg in previous year to 20.2kg (FAO, 2022b). The reasons for the initial decline in seafood consumption are numerous. First, there was widespread misinformation that fish could carry the SARS-CoV-2 in the early months of 2020, which was linked to media images of the Wuhan seafood market (Jamwal & Phulia, 2021), even though aquatic animals (finfish, reptiles, amphibians and invertebrates such as crustaceans and mollusks) play no epidemiological role in spreading COVID-19 to humans (Bondad-Reantaso et al., 2020; FAO, 2020c; Godoy et al., 2021). Considering the infodemic¹¹ and misinformation that were already established in the society before the pandemic, but were exacerbated by COVID-19, mostly due to incorrect use of social media; the appropriate management of future crises in the aquaculture sector should **promote rapid, creative and effective communication campaigns to mitigate such effects**.

Second, during the early stages of the pandemic, there were sudden changes in consumer behavior, including a surge in consumption of prepared foods, while the consumption of fresh

¹¹An overabundance of information – some accurate and some not – that makes it hard for people to find trustworthy sources and reliable guidance when they need it.

foods particularly fish and seafood products was disproportionately affected (Workie et al., 2020; J. Zhang et al., 2020). Studies in Europe, Asia and Latin America have reported decreases in seafood consumption intakes from 9.4% to 31.3% during the first wave of COVID-19 (Mignogna et al., 2022). Another explanation is that fresh seafood preferred by customers in several economies could not be delivered outside the provincial area during the restriction periods due to the difficulty of maintaining the quality of chilled products.

Furthermore, job losses and reduced incomes during this period significantly reduced purchasing power, which affected the expenses on fish purchases. The cancellation of major seafood trade events such as the Lunar New Year celebrations in China during the early stages of the pandemic and low demand for seafood from the HORECA sector also affected seafood consumption (Havice et al., 2020).

II.7.2. Increased demand for local seafood

In the early months of the COVID-19 pandemic, there was a rapid increase in demand for local and direct seafood from alternative sources in the United States and Canada, at a time when many other segments of the broader food system were disrupted (Stoll et al., 2021). In China, food consumption surveys, conducted in the Jiangsu province, found that rural households involved in agricultural/aquaculture production increased their consumption of aquaculture products in the short term (2020), compared to 2019, and these changes persisted even one year after lockdown was lifted (2021) (Tian et al., 2022). The Jiangsu province is one of the richest provinces in China and is famous for its aquaculture and rice production, which may have contributed to preserve the consumption of aquaculture products and food security, exhibiting the **importance of rural farmers and aquaculture to food security**.

II.8. Exacerbation of sex and gender inequalities

Women's contribution to aquaculture is often not recognized globally, mainly because the seafood industry has a strong gendered vertical division of labor, with women occupying low-income jobs, mainly in the secondary sector, and men occupying the top jobs¹². Women in the seafood industry play a key role in ensuring food security for all. In the primary fisheries and aquaculture sector, about 21% of the workforce in 2020 were women, but this number rises to nearly half the workforce when both primary and secondary fisheries and aquaculture sectors are considered (FAO, 2022b). Other reviews indicate that women may represent between 56% and 99% of the workforce in the post-production nodes of aquaculture (Kruijssen et al., 2018).

Women's employment status in the seafood sector appears to have declined more than that of men, as the secondary sector was particularly hard hit by the pandemic. A study of gendered predictors of the impact of COVID-19 on cross-border fish trade in Zambia and Malawi found that a higher proportion of women than men reported facing high impact of COVID-19. Moreover, educated and experienced male traders were less likely to face high impact of COVID-19. In contrast, female traders with larger family sizes and from households managed by single-heads were more likely to face high impact of COVID-19 (Mwema et al., 2022). In addition to job loss, women had to bear much of the responsibility for caring and educating children when schools closed and for keeping their families safe during the uncertain times (Jamwal & Phulia, 2021).

In this regard, intergovernmental agencies have been key to understand such impact in the Asia-Pacific region. A SEAFDEC study developed in 2021 found that in terms of gender roles, there were no changes in small-scale and commercial fishing activities before and during the COVID-19 pandemic. In Thailand, the gender roles in small-scale fishing activities were the same before and during COVID-19; however, men's inland capture fishing activities intensified during the pandemic (SEAFDEC, 2022a). In Papua New Guinea women are the majority of fresh food vendors, including fish products, and are considered most impacted than men during the lockdown period (Robins et al., 2020). Noteworthy, there is still insufficient data on this issue and proper conclusions will demand more analysis including analysis of sex-disaggregated data.

¹² Briceño Lagos. Why use a gender lens to analyze the impacts of COVID-19 on the seafood industry. The International Organization for Women in the Seafood Industry. Accessed: 18 January 2023. Available in: <https://womeninseafood.org/why-using-a-gender-lens-to-analyse-covid-19-impacts-on-the-seafood-industry/>



III. SECTION 3: ACTIONS AND POLICY MECHANISMS TO COPE WITH THE COVID-19 CRISIS IN THE AQUACULTURE SECTOR OF APEC ECONOMIES

Key messages:

- » The main goal of the measures introduced by governments within the context of the COVID-19 pandemic were to protect public health in the industry, ensure the basic livelihood and maintain the supply chain operative.
- » Economic support was the number one measure requested by aquaculture farmers.
- » The high informality and lack of social protection of SSA enterprises in developing economies made it difficult to access economic support packages.
- » Fisheries and aquaculture specific economic relief packages in developing economies were introduced mostly in the form of low interest credits and loans for SSA.
- » In developed APEC economies, such as Canada; Japan; New Zealand and the US, general and Fisheries sector-specific economic compensation for the extra costs for the pandemic response were introduced in various forms, particularly for the processing sector.
- » Measures to secure the aquaculture supply chain and to promote new markets were the most frequently adopted measures.
- » The institutional purchase of food and the promotion of seafood consumption contributed significantly to absorb stagnant production.
- » The pandemic has accelerated the trend towards digitalization and e-governance within fisheries and aquaculture government agencies.
- » Sex-disaggregated data and gender statistics are still not properly collected and are key to formulating inclusive policies.

COVID-19 had an abrupt, prolonged and mixed impact on the aquaculture sector of APEC economies, as discussed in the previous section. This forced all aquaculture stakeholders: governments, intergovernmental organizations, NGOs, industries and businesses, farmers and consumers to take action to address the ongoing crisis. In this section, relevant policies for the aquaculture sector implemented by APEC economies at the economywide level were identified along with the most common coping strategies adopted by farmers. Prior identification of the policies was performed during application of questionnaires and interviews, and information was complemented by consulting official websites of government agencies for the fisheries sector. Additionally, some policies were previously identified in consulted articles and reports. Policies at the municipal levels are more difficult to identify and obtain and were beyond the scope of this report.

III.1. Main objectives and diversity of the introduced policies

- (1) Protect public health in the industry
- (2) Ensure the basic livelihood
- (3) Maintain the supply chain operative

Initially, most of the policies adopted by governments were not specifically aimed at fisheries or aquaculture, although aquaculture producers could benefit from several of them, especially those designed for SMEs. The present report focusses mostly on those

specific to the fisheries and aquaculture sector. At the global and regional levels, intergovernmental agencies such as FAO, OECD, SEAFDEC have published several policy recommendations to support the fisheries and aquaculture sector since the beginning of the pandemic (FAO, 2020 a,b,c,d,e, 2021a,b, 2022a,b,c; FAO WorldFish, 2021; OECD, 2020,2021; SEAFDEC, 2022a,b).

In response to the evolving and complex nature of the problem, responses varied (See Figure 16). Measures perceived as **most effective by fish farmers were the use of digital platforms/online markets, technical assistance, financial assistance and moving to sales services**, as seen in Malaysia during the initial restrictive period (Azra et al., 2021).

Classification of measures:

- Health and safety measures
- Financial measures
- Social protection and employment measures
- Supply chain and marketing measures
- Management and technical measures
- Promoting digitalization, innovation and sustainability
- Promoting sex and gender equality

III.2. Limitations of the policies implemented for the sector

In addition to programs for SMEs and measures specific to fisheries and aquaculture, the responses to the pandemic included measures to strengthen the health system and vaccination programs, which varied widely according to each economy healthcare system, its capacity, quality of care and accessibility. These measures had a profound impact on the duration and magnitude of the crisis and certainly on the process of economic recovery for aquaculture but are beyond the scope of this report. The United Nations Development Programme (UNDP) analysis suggested that **the economic recovery rate is predicted to be faster for economies with higher vaccination rates**, with about USD7.93 billion increase in global GDP for every million people vaccinated¹³.

Moreover, high-income economies and groups with access to medical resources (vaccines, protective equipment, therapy), government support (i.e., financial stimulus, social safety nets), and personal savings have fared better. The coverage of the social protection systems in developing economies was lower than in developed economies, limiting not only the initial financial compensation needed for work interruptions and job losses. In general, the availability of public resources has been the main constraint in action.

When consulted about main difficulties faced by APEC economies in implementing support measures for the aquaculture sector, official government representatives from Thailand cited “inadequate budget allocations and the need to involve vulnerable groups in such policies and programs, as well to build confidence in vaccination”. Meanwhile Japan’s representative highlighted the following:

“Shortage of staff in central and local governments to cope with the increased workload and lack of digitalization of administrative procedures. In addition, in shifting the destination of aquaculture products from the food service industry to household consumption and school meals, the lack of processing plants and workforce to meet the specific requirements for such destinations was the main problem”

An important lesson from the pandemic was the need for clear contingency mechanisms to deal with such crises:

“Response protocols are essential for responding to future crises. This was a fundamental lesson. What is the chain of authority for decision-making? Who is responsible for activating these procedures? Finally, these protocols now need to be designed not in times of pandemics or external shocks, but during “normal” times. We

¹³ Estimates until October 2021. Impact of vaccine inequity on economic recovery. United Nations Development Programme. Accessed 18 January 2023. Available in: <https://data.undp.org/vaccine-equity-archive/impact-of-vaccine-inequity-on-economic-recovery/#:~:text=UNDP%20analysis%20suggests%20that%20the,for%20every%20million%20people%20vaccinated.>

should always have a backup plan in place, anticipating that these shocks may occur more often in the future”

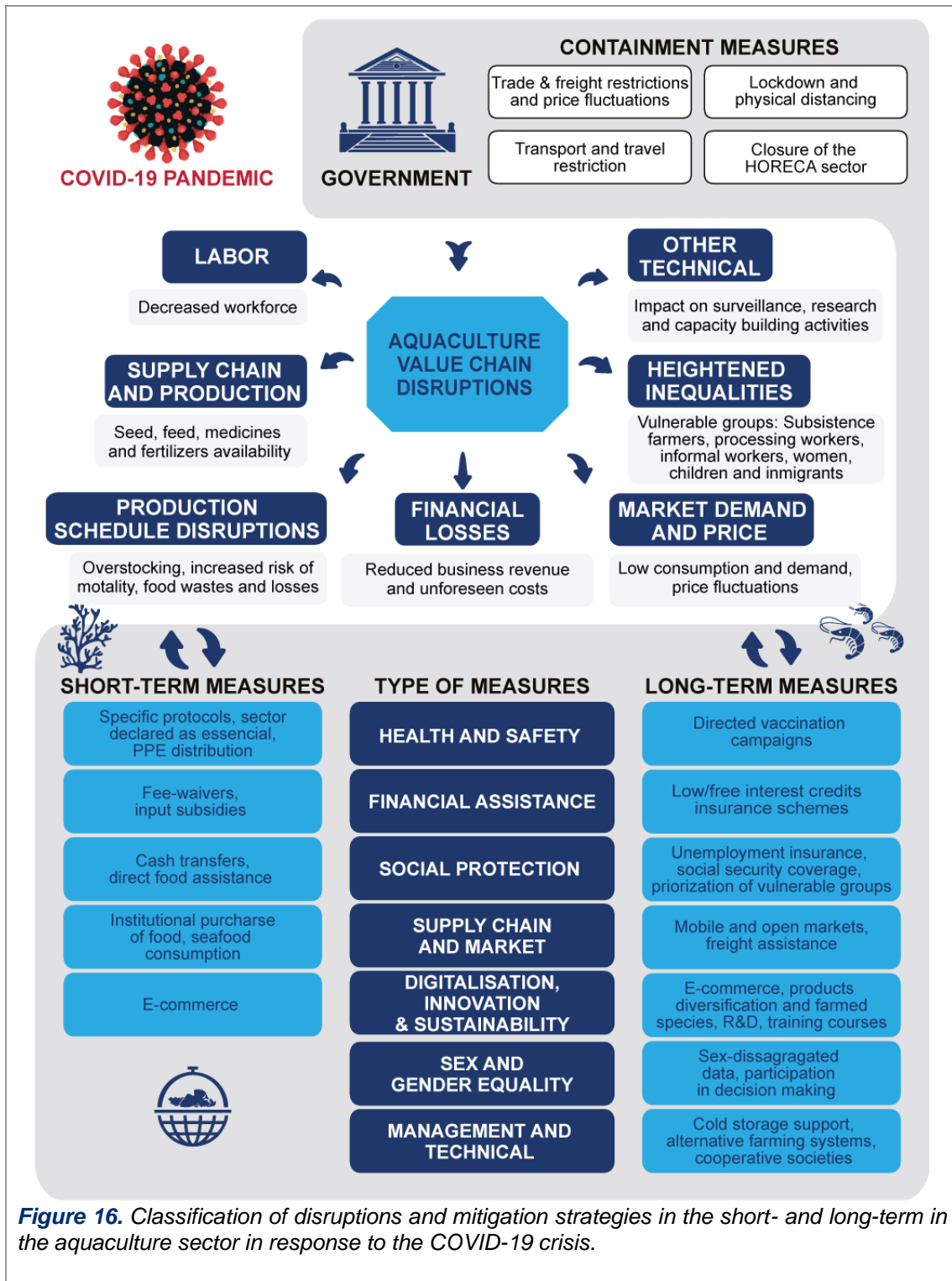


Figure 16. Classification of disruptions and mitigation strategies in the short- and long-term in the aquaculture sector in response to the COVID-19 crisis.

The uncertainty of the markets was another major concern, as not much was known about the pandemic. Internally, situations with officials who were afraid to go to work on some inspections were reported in Chile, however workforce groups were created for those mandatory physical inspections, which complemented the wide implementation of online procedures.

III.3. Health and safety measures

The novelty of the COVID-19 crisis **required the rapid development and implementation of specific health and safety regulations** to protect aquaculture workers at all stages of the aquaculture supply chain, including consumers and the processing sector, from the risks of the infection itself, which may not have been implemented fast enough in all cases, exposing these workers and their families to increased risks of infection as seen in the major COVID-19 outbreaks documented at seafood processing plants around the world¹⁴.

The main measures adopted by the aquaculture industry included social distancing, mandatory use of masks, increased frequency of cleaning and provision of soap and sanitizers by the company. Social distancing and the related work shifts were the most adopted internal mitigation measures in the aquaculture sector worldwide (Lorena et al., 2022; Mangano et al., 2022). These health measures were of great importance during the pandemic, as their implementation significantly reduced the spread of COVID-19. In Chile, up to 67% of salmon industry stakeholders surveyed reported that the company where they were employed had implemented health measures due to the COVID-19 pandemic and more than 50% of the respondents indicated that the implementation of the safety measures was moderately difficult, although was very effective and relevant (Lorena et al., 2022).

The fish processing sector is labor-intensive and requires workers to be in close proximity for long periods of time, in low temperatures, and often involves shared housing and transportation, which exacerbated the risk of virus transmission during the COVID-19 outbreak (ILO, 2021). The safety measures developed by the secondary sector significantly increased the production costs. This justifies that in some economies such as the US and Canada **specific relief packages for the seafood processing sector** were launched.

To ensure compliance with and confidence in sanitary standards, it is recommended that a centralized, empowered and with defined functions sanitary authority for the fisheries and aquaculture sector be present in the respective economy. The pandemic has highlighted the importance of avoiding variations and inconsistencies in the working competencies of specific fisheries agencies and provides an opportunity to work on legislation to correct them. The recommendations outlined by (Chang et al., 2022) for China on this issue can be applied to other APEC economies (Box 5).

Box 5. The Impact of the COVID-19 on China's Fisheries Sector and its Countermeasures (Chang et al., 2022).

Researchers from China analyzed the current (2022) legal safeguards measures put in place by the Chinese government to mitigate the effects of the pandemic in the fisheries sector and concluded with three major policy recommendations:

- (1) Legalization of policies**, it is considered urgent for China to formulate specific laws and regulations to regulate the quality and safety of aquatic products.
- (2) Provide free legal advice and support to fishers** to enhance the legal awareness of fisher's groups.
- (3) Establish a specialized fishery product monitoring agency**, as local fishery monitoring departments and testing institutions have different and inconsistent working competencies.

¹⁴ Amanda Moeser, "The most dangerous job in fishing isn't fishing—it's processing fish during a global pandemic", Union of Concerned Scientists: Science for a healthy planet and safer world (blog), 21 November 2020. Accessed: 18 January 2023. Available in: <https://blog.ucsusa.org/science-blogger/the-most-dangerous-job-in-fishing-isnt-fishing-its-processing-fish-during-a-global-pandemic/>

Critical shortage of personal and protective equipment (PPE) was reported worldwide and actions to provide AVC workers with protocols, equipment and materials to prevent transmission of COVID-19 have been extremely beneficial in terms of health and safety of the people, the availability of enough workforce for companies and securing the supply chain, as seen in South Asia (SEAFDEC, 2022b).

Additional health and safety measures taken by APEC economies can be seen next:

Table 5. Selected health and safety measures implemented by APEC economies to support aquaculture in response to the COVID-19 pandemic.

Chile

- ☞ Safe pass for fish and aquaculture related industries (March 2020).
- ☞ Salmon farms converted their laboratories into COVID-19 testing centers to allow health authorities to conduct tests on coronavirus samples¹⁵.
- ☞ Action plan for the coronavirus in the salmon industry supply chain (April 2020).

The Philippines

- ☞ The Philippines introduced the “Food Lane Conduct Pass” to ensure the unimpeded supply and flow of food commodities, including fishery products, and inputs, and to facilitate the mobilization through quarantine checkpoints.

Thailand

- ☞ Specific health guidelines for COVID-19 in the aquaculture sector.
- ☞ The DOF issued certificates to the operators who comply with measures to prevent COVID-19 contamination in aquaculture farms, fishing vessels, fish markets, quays, and central markets to enhance consumers’ confidence in domestic and foreign markets (SEAFDEC, 2022b).

III.4. Financial measures

II.4.1. General packages vs specific fisheries financial support

The request for economic support was the most important external mitigation measure requested by aquaculture farmers worldwide, including APEC economies (Mangano et al., 2020, Lebel et al., 2021). The fisheries and aquaculture sectors have mostly benefited from general support packages for SMEs, although in some economies specific fisheries and aquaculture financial packages have been introduced, such as in Canada; Chile; Peru and the US. The OECD stated that the need for and extent of fisheries and aquaculture-specific support programs depended on both the economy-wide context of the sector (relative contribution to GDP) and the complexity of the impacts of COVID-19 (OECD, 2021).

Several characteristics of the sector, such as the seasonality of work, the employment of foreign crew and relatively high levels of informality and self-employment, mean that general stimulus packages alone may not have been as effective. In Thailand, Mr. Cherdsak Virapat, General Director of the Centre for Integrated Rural Development for Asia and the Pacific (CIRDAP) highlighted the situation of access to financial assistance for small-scale farmers:

“Many small-scale farmers have debts and don’t have access to loan contracts. Few farmers have access to microcredit provided by the bank. Farmers should be encouraged to form cooperatives or groups to share their knowledge, plan, and implement activities to increase their business power”

¹⁵ Adolfo Alvial Muñoz, “De ISA en salmones a covid-19 en humanos: Similitudes y lecciones”, AQUA. Accessed: 18 January 2023. Available in: <https://www.aqua.cl/columnas/de-isa-en-salmones-a-covid-19-en-humanos-similitudes-y-lecciones/>

Similar situations, although probably to a lesser extent, manifested in developed economies such as Chinese Taipei for instance:

“Some of the culture places are not registered due to some difficulties such as property ownership, land rent, unlicensed water source...etc., and therefore the farmers who culture animals in the specific place are not eligible to apply for subsidy. The law of registration for culture license should be properly scrutinized and reformed to solve the problem and the standards should be untightened”

Peru introduced fisheries and aquaculture-specific low interest credits for micro and small aquaculture (AMYPE) and for limited resources or subsistence aquaculture (AREL) in May 2020. The special credits program was developed by the Peruvian Fisheries Development Fund (FONDEPES). Fish farmers were required to have an authorization resolution for each type of aquaculture in force. In the case of loans for AREL systems, farmers were required to belong to native and indigenous communities with resolutions granted by their respective Regional Government agencies. The maximum value of the credits were PEN (Peruvian soles) 2000 or USD520, with a six-month grace period, 3% annual interest and up to 36 months to pay. Peruvian aquaculture is mainly composed of AMYPE (23.9%) and AREL aquaculture (74.7%)¹⁶, while authorizations for large-scale aquaculture only represent 1.4% of the total. This explains the necessity (among other reasons) to introduce such packages.

The Peruvian Ministry of Production confirmed the following information: *“In the framework of this program, in 2020, 501 credits were awarded, benefiting 365 AREL farmers and 136 AMYPE farmers, for PEN1,002,000.00 soles for working capital”*. Recently (2023), the Peruvian government has expanded the funding for FONDEPES for similar credits from PEN12 million soles to PEN30 million.

A complete list of identified financial measures implemented by APEC economies in responses to the COVID-19 crisis is presented in Table 6 and details about the actions or programs can be seen throughout this section.

Table 6. Selected financial measures implemented by APEC economies to support aquaculture in response to the COVID-19 pandemic.

Australia

- ☞ All the fees in Commonwealth fisheries for 2020 were waived.
- ☞ General measure - Payment arrangements for overdue debts to businesses and customers facing financial hardship after being affected by natural disasters or COVID-19.

Canada

- ☞ The Canadian Seafood Stabilization Fund provided funding to the fish and seafood processing sector to increase storage to deal with excess inventory, ensure the health and safety of workers and of the local food supply, implement advanced manufacturing technologies and adapt to changing needs and demand.
- ☞ The Mandatory Isolation Support Program for Temporary Foreign Workers to assist the farming, fish harvesting, and food production and processing sectors by covering the incremental costs associated with the mandatory 14-day isolation period imposed on foreign workers upon entry into Canada under the Quarantine Act.

Chile

- ☞ Aquaculture specific grants: “PAR Chile Apoya Acuicultura de Pequeña Escala (APE) y MyPEs acuícolas”, for micro and small aquaculture companies, with 100% financing

¹⁶ Ministry of Production (PRODUCE). Catastro Acuicola Nacional. Accessed: 17 January 2023. Available in: <http://catastroacuicola.produce.gob.pe/web/>

of individual project with a maximum of 4 million pesos (USD4,400). Additional regional plans have been developed within the scope of this program.

Indonesia

- ☞ Warehouse Receipt Program, through which seafood producers stored their production in designated cold storage facilities and receive a receipt to use as collateral for the bank-backed loan (up to 70% of the value of their catch) at 6% interest per year.

Japan

- ☞ General measure - Sustainability benefits to support the continuation for businesses that were severely affected by the spread of the infection (sales reduced by 50% or more by December 2020 (1 May 2020 to 15 February 2021), including fishers, cooperatives and processors of fishery products.
- ☞ General measure - Temporary support to mitigate the impact of the declaration of a state of emergency, small, medium size and individual businesses (including farmers, fishers, etc.) affected by the shortened business hours of restaurants or refraining from going out due to the declaration of a state of emergency and with a decrease in sales by 50% or more received support from the government through a temporary support fund system (January 2021 to 31 May 2021).
- ☞ General measure - Monthly support money to small and medium-scale enterprises and sole proprietors (including fish farmers and fishers) who have experienced a decrease in monthly sales of 50% or more due to the effects of restaurant closures and shortened business hours, and who self-restricted themselves from going out due to the declaration of a state of emergency or priority measures to prevent the spread of disease (26 June 2021 through 7 January 2022).
- ☞ General measure - Business revival support money, which included benefits to small and medium-sized corporations and sole proprietors (including fish farmers and fishers), who as a direct or indirect result of the coronavirus pandemic (31 January 2022 through June 2022), experienced a 30% or more decreased revenue in any month from November 2021 to March 2022 compared to a base month from November 2018 to March 2021.
- ☞ General measure - Subsidies to support the introduction of machinery and equipment for market recovery.
- ☞ The Rent Support Benefit to reduce the burden of land rent, in favor of workers in agriculture, forestry and fisheries (large companies are not eligible).

Korea

- ☞ The government allocated USD2.4 million to provide low interest (1.3%) loans to aquaculture households and fisheries businesses facing cash flow difficulties due to COVID-19.

Malaysia

- ☞ In the second economic package the government included the allocation of a special fund of MYR200,000 to fishermen's associations to assist them in developing short-term agri-food projects that can produce food within 3 to 6 months and ensure the food supply.
- ☞ Recovery plans to revive the fisheries and aquaculture sector by including the sector in the short, medium and long-term development plans.

Mexico

- ☞ The annual incentive of the Support Component for the Well-being of Fishermen and Aquaculturists "Bienpesca" was advanced to be delivered in May 2020 to help small-scale producers maintain their activity in the face of the COVID-19 contingency.

- ☞ Subsidies for fuel, refrigerated vehicles for the transportation of fish and reductions of duties and tariffs for the importation of essential fishing tools and equipment.

New Zealand

- ☞ General measure – Help for businesses to pay their employees while they waited for PCR test results (Short-Term Absence Payment) and for business staff who could not work because of self-isolation (Leave Payment).
- ☞ General measure - The “COVID-19 Wage Subsidy”, which helped businesses pay employees who could not work, and had a 30% decline in revenue (March 2020).
- ☞ General measures - The Income Relief Payment was a temporary, short-term payment for people who lost their jobs (March-June 2020) and the Essential Workers Leave Support for employees of essential businesses with a decrease in revenue (April 2020).
- ☞ General measure - The Small Business Cash Flow Loan Scheme, which provided loans to small businesses, including sole traders and the self-employed, affected by COVID-19 to support their cash flow needs, enterprises should have experienced at least a 40% decrease in revenue over a consecutive 7-day period to be eligible.

Peru

- ☞ General measure: Access to credits for small and medium-sized companies through the “Reactiva Peru” and “FAE-MYPE” programs. The “Reactiva Peru”, although not specific to the sector, benefited several small and medium-sized enterprises in the fisheries and aquaculture sector.
- ☞ Financial credits for up to USD525 for artisanal fisheries and aquaculture with limited resources for a total of USD4.4 million, starting in May 2020.
- ☞ Technical support and free assistance to managers of businesses in the seafood sector in order to improve the productive processes, by means of the promotion of e-commerce and trade networks with the virtual platform “Reactivación en Marcha.”

Singapore

- ☞ General measure - Temporary Bridging Loan Program for business owners to borrow up to approximately SGD3.7 million for working capital payable for five years (April 2020).
- ☞ General measure - The Foreign Worker Levy Rebate which was a waiver of the monthly Foreign Worker Levy Fee by providing businesses with SGD555 rebate on the levy paid for each Work Permit/Special Pass Holder (April 2020).
- ☞ General measure - Jobs Support Scheme as wage support for employers to retain local employees during the period of economic uncertainty by co-funding a proportion of the first SGD3,400 gross monthly wages paid to each local employee (February 2020).

Chinese Taipei

- ☞ General measure - Direct subsidy to farmers NTD 10000-30000 per person.
- ☞ Subsidy to farmers when reducing culture amount or for longer culturing period.
- ☞ Interest free loans for one year, and monetary benefits to grouper farmer if they were awarded with traceable agricultural products certification and loans to sellers if their selling amount fell 20%.

Thailand

- ☞ General measure: Direct income for small scale aquaculture with USD163 per farmer (April 2020).
- ☞ Low interest loans with the government support of 3% annual interest rate.

The United States

- ⑤ The COVID-19 Fisheries Assistance (12005) of the CARES Act 2020 in support of private aquaculture businesses in US states, tribes and territories, from 26 May 2020 through 12 October 2021.
- ⑤ General measure - The Paycheck Protection Program, an emergency disaster loan program designed to provide funds to small businesses with less than 500 employees, beginning 3 April 2020.
- ⑤ General measure - The COVID-19 Economic Injury Disaster Loan (EIDL) offered loans to ensure that businesses had access to working capital and could pay for all business expenses they may incur while it is recovering from the disaster.
- ⑤ The Coronavirus Food Assistance Program 1 provided direct assistance to producers of specified agricultural commodities including seafood products, who suffered a price decrease of 5% (May 2020 to September 2020).
- ⑤ The Coronavirus Food Assistance Program 2 included assistance to producers of all species of aquatic organisms grown for human consumption, fish raised as feed for fish that are consumed by humans, and ornamental fish. (September 2020 through December 2020 and April 2021 through October 2021).
- ⑤ The Seafood Processors Pandemic Response and Safety Block Grant Program, funds to provide grants and loans to seafood processors and processing vessels for costs incurred in response to the coronavirus pandemic.
- ⑤ The Tribal Seafood Pandemic Response and Safety Grant Program provided grants to seafood processors owned and operated by Federally Recognized Indian Tribes. (Final Application 18 April 2022).
- ⑤ In April 2020, the 25% tariff on tilapia imported from China to the United States was removed, which softened the blow of the pandemic and contributed to the growth of the tilapia industry seen in China in 2020 (Dai et al., 2022). However, the tariff was reinstated in August of that year.

II.4.2. The major role of governments in financial assistance

Governments have been the main source of support, although cooperative societies and trade associations have also played an important role in supporting people in aquatic food value chains. NGOs have also supported the fisheries and aquaculture sector during the crisis in developing economies (Aliyah et al., 2021). Public data was used by decision-makers as a reliable database of current workers eligible for emergency relief funds (Maruff, 2020). The open question is whether the level of cash transfers and the delivery mechanisms adopted by economies were effective in mitigating the shock to the sector and whether they are still needed. This can be assessed by analyzing available high-quality transparent public data on the beneficiaries of such programs.

Easier access to financial compensation for the temporary suspension or reduction of production and control measures were introduced for the aquaculture sector in several APEC economies mostly through low interest credits and loans, fee waivers, payment deferral, payroll tax refunds, tax rate reductions, input subsidies (ice, fuel, nets, etc.). Economy-wide or local governments subsidized bank loans, extended loan contracts and/or reduced interest rates, so small businesses did not have to pay for the last year because of COVID-19. Furthermore, financial support to farmer's organizations for the temporary storage of aquaculture products for human consumption, to ensure market stability and reduce the risks of products being wasted or diverted to non-human food uses was an important tool for immediate economic mitigation, discussed in the [Section 3.6](#).

Relaxed loans and credit terms were helpful for farmers with repayment problems, but SSA farmers are less likely to borrow in response to impacts, so special attention needs to be paid to the credit needs of small farmers is required as seen by Lebel et al., (2021) in Thailand and Viet Nam. Direct financial assistance, developing new markets and promoting resilient supply chains have been identified as effective measures (Mangano et al., 2022).

The pandemic has strengthened the role of governments around the world to addressing the health and economic crisis, however, poor economies cannot rely on the government alone to address all the needs of the sector. In this sense, as one interviewees point out:

“Linkages or collaborations between government agencies, the private sector, research institutions, or the academy can be more efficient and beneficial to all concerned parties. The research institutions or the academy can provide the science-based technologies developed through research. The private sector can provide the capital, and the government agencies can supervise and monitor the project. These joint efforts can accelerate development and help increase production for the small-scale aquaculture sector”.

Policies that reduce the cost of inputs, such as fuel subsidies, while beneficial, are not the most inclusive, because they tend to favor large companies over small producers. In 2017, such policies accounted for 40% of the direct support to individuals and companies in the fisheries sector, as reported in the OECD Fisheries Support Estimate database, for 27 OECD economies. The OECD recommends that the goal should be to move away from such policies and instead, where possible, provide direct income support through targeted cash transfers instead, to the benefit of both livelihoods, the environment and the sustainability of the sector (OECD, 2021). For example, Mexico provided subsidies for fuel, refrigerated vehicles to transport fish and reductions in duties and tariffs on the importation of essential fishing tools and equipment in an attempt to lower the market prices at which fishers sell their catch to local processors.

II.4.3. Extensive financial support for the aquaculture and fisheries in developed economies

In the US numerous programs were developed to assist general SMEs, including fisheries and aquaculture companies, while also specific fisheries and aquaculture programs were introduced. Most programs were designed to compensate for the additional costs incurred during the pandemic response with non-payable and payable credits and grants. In the case of Japan and New Zealand, numerous general financial assistance programs were established in the form of direct economic relief and credits, some of them ended up benefiting aquaculture farmers ([See Table 6](#)).

The US [Paycheck Protection Program](#) (PPP) was an emergency disaster loan program administered by the Small Business Administration (SBA) designed to provide funding to small businesses with fewer than 500 employees who were affected by the 2020 coronavirus pandemic. The PPP loans were up to 2.5 times the average monthly payroll in 2019 (with different payroll windows available for seasonal or startup businesses) to pay up to 8 weeks of payroll costs, including benefits. Funds could also be used to pay mortgages interest, rent and utilities.

Annual wages were capped at USD100,000 for payroll calculation purposes. To be eligible for payments, an individual or legal entity had to have an average adjusted gross income of less than USD900,000 for tax years 2016, 2017, and 2018. Funds were fully forgiven if used for payroll costs, mortgages interest, rent, and utilities (if at least 75% of the forgiven amount must have been used for payroll). Loan payments were deferred for six months. No collateral or personal guarantees were required. Neither the government nor lenders charged fees to small businesses. Interest rate was 1%, and the loan was to mature in two years.

The US allocated USD300 million for fisheries and aquaculture businesses under the [Coronavirus Aid Relief and Economic Security \(CARES\) Act](#). The categories for funding were direct payments, fishery-related infrastructure and fishery-related education. Within this framework the [Coronavirus Food Assistance Program 1 \(CFAP-1\)](#) was implemented, which consisted of direct assistance to producers of agricultural commodities who suffered a price decline of 5% or greater due to the pandemic, and who incurred substantial marketing costs on their inventories. To be eligible for payments, an individual or legal entity had to have an average adjusted gross income of less than USD900,000 for tax years 2016, 2017, and 2018. However, if 75% of their adjusted gross income was derived from farming, ranching, or forestry, the limit of USD900,000 did not apply.

For the [CFAP-2](#), in effect from September 2020 to October 2021, all species of aquatic organisms grown for human consumption, fish raised as feed for fish consumed by humans, and ornamental

fish, propagated and reared in an aquatic medium were eligible. Eligible sales included only sales of raw commodities grown by the producer. The portion of sales resulting from value added to the commodity, such as processing and packaging, and from sales of products purchased for resale were not included in the payment calculation.

The USDA launched the “Seafood Processors Pandemic Response (SPPR) and Safety Block Grant Program in 2021 with approximately USD50 million in funding to provide grants and loans to seafood processors and processing vessels for pandemic response costs, including measures to protect workers against novel coronavirus. State agencies issue payments for costs incurred between 27 January 2020, the date upon which the public health emergency was declared by the US Department of Health and Human Services and 31 December 2021. For example, costs associated with paid sick leave for an employee or housing for workers’ quarantine due to COVID were eligible for funding. However, lost revenue due to spoilage or lost production were not eligible for reimbursement under the SPPR Grant.

The Economic Injury Disaster Loans (EIDL) was a program established prior to COVID-19 that distributed loans from the SBA to help small businesses whenever a disaster was declared by the federal government. The loans ensure that a business has access to working capital and can pay for all business expenses while recovering from the disaster. As a result of the economic impact of COVID-19, the entire economy was declared a disaster area and several changes were made to the program. First, in addition to the traditional EIDL program, the CARES Act provided USD10 billion to the SBA to fund a new EIDL Advance program. Low-interest loans and loan advances were available to small business, agricultural business (including aquaculture) and private non-profit organizations. EIDL assistance was available only to small businesses when the SBA determined that they were unable to obtain credit elsewhere. The maximum amount was USD2,000,000 for loans and up to USD10,000 for loan advances. The repayment period was up to 30-year.

In Canada, the Canadian Seafood Stabilization Fund provided CAD (Canadian dollar) 62.5 million to help applicants: (1) increase storage to deal with excess inventory, (2) ensure the health and safety of workers and the local food supply, (3) adopt advanced manufacturing technologies and (4) adapt to changing needs and demand, only aquaculture processing sectors were eligible for this fund. However, the fund could be used to aid in the farming of aquaculture products.

During the interview with the representative of Chinese Taipei representative, several financial support programs for fish farmers in place during the pandemic crisis were listed:

“There were programs to support financially such as giving subsidy directly to farmers NTD10000-30000 per person (USD329-989), subsidy when reducing culture amount, interest free loan for 1 year, subsidy for longer culture period (reducing selling pressure), help to obtain Aquaculture Stewardship Council certification (for grouper), help open oversea market for ornamental fish, grouper, tilapia and soft shelled turtle, subsidy for transportation fee to overseas market (grouper and tilapia), subsidy for drug residue testing, money to sellers if the selling amount decreased by 20%, money for grouper farmers if they were awarded with traceable agricultural products certification and subsidies for packaging materials, processing, frozen storage, canning, etc”

Additionally in the island, credits were available to fishers and aquaculture farmers through the “Credit Department of the Agriculture and Fisheries Association” and the “Agricultural Bank of Chinese Taipei”.

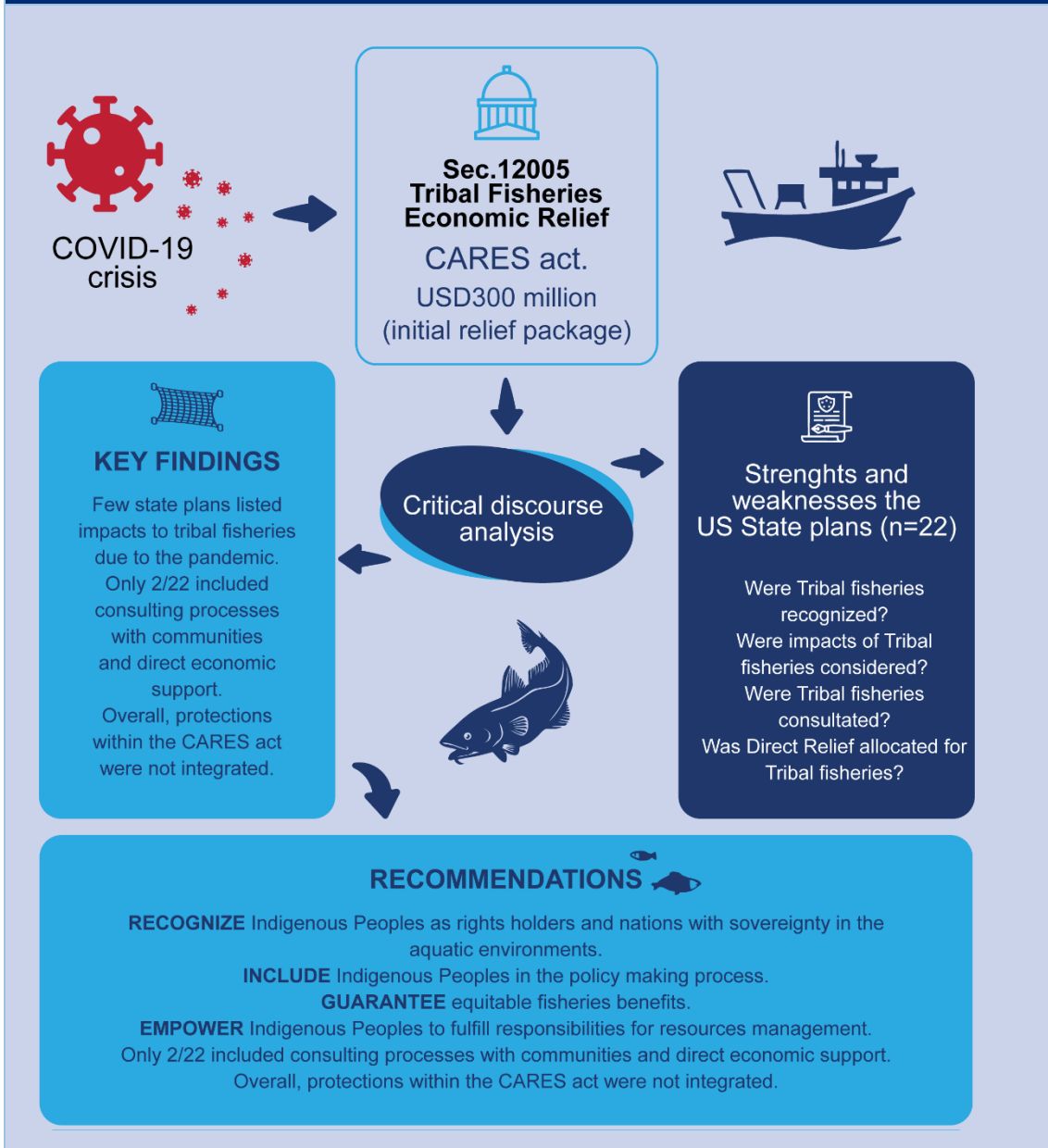
II.4.4. The need for inclusive financial assistance

Financial assistance policies, particularly in crisis events, must include all vulnerable groups within their plans and guarantee conditions that allow them to receive such benefits. A global assessment on sources of injustices across aquatic food systems in policy documents found that a frequent failure is that policies lack or do not specify how different groups can participate in the decision-making processes (Hicks et al., 2022).

Leonard, (2021) analyzed the inclusion of Tribal Fisheries in some of the implemented COVID-19 policies for the fisheries sector in the United States through Social Discourse Analysis showing

that few State plans recognized the impact of the pandemic on these group and considered direct financial relief for Tribal Fisheries, even when the Federal Sec. 12005 Tribal Fisheries Economic Relief recognized their importance (Box 6).

Box 6. Sustaining tribal fisheries: the US economic relief policies during COVID-19 (Leonard, 2021).



The USDA created the program “The Tribal Seafood Pandemic Response and Safety” in 2022, which provided grants to seafood processors owned and operated by Federally Recognized Indian Tribes, as defined in the List Act of 1994 (Pub. L. No. 103—454). The program was developed in response to extensive stakeholder feedback from Tribal representatives indicating that they were significantly impacted by the COVID-19 pandemic and were receiving inadequate federal assistance. The grant program provided funding to help offset the costs of measures taken by companies to protect workers from novel coronavirus. Approximately USD1,000,000 was available to fund applications. Funds could be used to cover costs incurred between 27 January 2020 and 31 December 2021. The minimum funding request amount was USD100,000 and the maximum USD500,000.

Small-scale fish farmers should have easy access to loans with few requirements and higher tolerance. For example, collaterals in loans are one of the most feared issues by fish farmers and fishers alike, since SSA farmers have limited physical capital to serve as collateral. In Indonesia, funding schemes with special characteristics for SSA are granted by the Maritime and Fisheries Business Capital Management Institute (“Lembaga Pengelola Modal Usaha Kelautan dan Perikanan”, LPMUKP), this agency was established in 2009 by the MMAF to improve access to capital and business advice to small-scale fish farmers and fishers, so that they are not burdened with debt to major cooperatives, which usually charge high interests, and are also not dependent on middlemen who provide loans but with significant impacts on purchase prices.

The role of this special agency is currently limited by funding and human resources to reach more small-scale fish farmers distributed in Indonesia’s regions. LPMUKP helped farmers during the pandemic by signing loan facility agreements to help absorb the impacts for fishers and fish cultivators affected by the COVID-19 pandemic with fisheries cooperatives and processing market groups, as well as developing loan restructuring programs with extension of the credit period for fish farmers and even a mentoring program that allowed to discuss and provide solutions to each producer’s problems.

III.5. Social protection and employment responses

COVID-19 has highlighted and exacerbated existing social inequalities and the weakness of existing forms of social protection in many economies (FAO, 2021a). Social protection is a human right, and according to the ILO, can be defined as a set of measures aimed at preventing poverty and vulnerability throughout people’s lives¹⁷.

Several social protection measures have been introduced by APEC economies to mitigate the impact of COVID-19 on the livelihoods and poverty of the general population (Table 7). Some of these measures may have directly benefited small-scale aquaculture farmers. However, the extent of the direct benefits from those measures for aquaculture workers is difficult to measure, yet most certainly informal aquaculture workers remained beyond the reach of these measures.

Table 7. Selected social protection and employment measures implemented by APEC economies to support aquaculture in response to the COVID-19 pandemic.

<p>Australia</p> <ul style="list-style-type: none"> General measure - Migrant visa arrangements to address labor supply issues during the COVID-19 crisis, such as extensions, permissions of regional travel and employee retention.
<p>Canada</p> <ul style="list-style-type: none"> Travel exemptions for all temporary foreign workers, including fish/seafood workers.
<p>Indonesia</p> <ul style="list-style-type: none"> Employment of thousands of fisheries workers who have lost their jobs due to COVID-19 was performed through the “Indonesia Coral Reef Garden”, the Economic Recovery Program and the “Mangrove Restoration Program” (SEAFDEC, 2022b).
<p>Japan</p> <ul style="list-style-type: none"> The opening of applications for residence and technical training, and the reception of foreign human resources related to fisheries.
<p>Malaysia</p>

¹⁷ International Labor Organization. Accessed: 18 January 2023. Available in: <https://www.ilo.org/100/en/story/protection/>

- Malaysia provided a one-off cash payment of MYR1,000 (USD247) to households belonging to the bottom 40 income group (monthly earning less than MYR4,000 (USD990), where most fishing households belong (Ferrer et al., 2021).

the Philippines

- Subsidy in the form of PHP2,000 (USD41), a voucher for food items and a cash voucher worth PHP3,000 (USD62) under the Cash and Food Subsidy for Marginal Farmers and Fisherfolk Program (Ferrer et al., 2021).

Thailand

- SSA benefited from direct economic assistance from the government (THB5,000 or USD163 per farmer per month during April–June 2020) and subsistence supplies (e.g. rice, instant noodles, preserved foods, etc.) from provincial governments (Chumchuen et al., 2022).

Furthermore, the loosening of travel and visa restrictions to attract foreign seasonal workers, and administrative flexibility with considerations for employees from the fisheries sector were introduced in Australia; Brunei Darussalam; Canada; Japan and New Zealand.

The World Bank has developed a tool considered a “living paper” that compiles social protection and labor measures planned or implemented by 223 world economies in response to COVID-19¹⁸. The document, updated through 2 February 2022 shows that all APEC economies, except for Papua New Guinea, introduced or extended general cash payments to vulnerable groups in the population. Such payments indirectly reached artisanal aquaculture farmers since they are part of the general population with less income.

¹⁸ World Bank. Accessed: 18 January 2023. Available in: <https://openknowledge.worldbank.org/handle/10986/33635>

Table 8. Overview of social protection measures by different components in APEC economies.

	SOCIAL ASSISTANCE					SOCIAL INSURANCE			LABOR MARKETS			
	Cash-based transfers	Public works	In-kind (in-kind school feeding)	Utility and financial support	Paid leave/une mployment	Health insurance support	Pensions and disability	Social security contributions (waivers/subsidy)	Wage subsidy	Activation (training)	Labor regulation adjustment	Reduced worktime subsidy
Australia												
Brunei Darussalam												
Canada												
Chile												
China												
Hong Kong, China												
Indonesia												
Japan												
Korea												
Malaysia												
Mexico												
New Zealand												
PNG												
Peru												
The Philippines												
Russia												
Singapore												
Chinese Taipei												
Thailand												
US												
Viet Nam												

Source: Extracted from Social Protection and Jobs Responses to COVID-19: A Real-Time Review of Measures. World Bank.

III.6. Supply chain and marketing measures

III.6.1. Securing the aquaculture supply chain

The most important and immediate measure taken to secure the aquaculture supply chain worldwide was the inclusion of aquaculture as an essential sector and the issuance of safe passes to transport either products or inputs, this was a measure that began to reactivate the industry. Most governments excluded fish production from lockdown orders from the beginning, though aquaculture was slowly recognized as an essential activity in some economies from Latin America.

Support for airfreight to maintain important international routes for high-value products, including highly perishable fish products such as chilled seafood was important in Australia and New Zealand, which suffered disproportionately from the collapse of air travel. Brunei Darussalam also created a top-up fund for aquaculture operators to bring in raw materials such as fish fry by chartered flight (SEAFDEC, 2022b).

Typically, Australian seafood exports are transported in the cargo hold of commercial aircraft, but with few international passenger flights under COVID-19 restrictions, the majority of outbound flights were cancelled, resulting in the loss of transport routes (Bernadette, 2020). The Australian Government's "International Freight Assistance Mechanism (IFAM)" was a temporary emergency measure to help restore these critical global supply chains, with aircraft departing from key Australian ports to deliver high-value Australian products to priority export markets.

IFAM helped move high-value perishable Australian products to existing international markets, including seafood products such as lobsters, given the cost of airfreight, low-value products were not eligible. The program began on 1 April 2020 and closed on 30 July 2022 and allowed Australia's fishers and fish farmers to deliver products to key international markets including China, Japan, Singapore and the United Arab Emirates. The IFAM was not intended to fully offset the increase in freight costs to pre-COVID19 levels. However, by contributing to a portion of the airfreight costs, the Government seek to ensure Australian exporters can reset and recover quickly when the COVID-19 crisis begins to abate.

The New Zealand Government established programs to ensure that critical supplies can continue to flow to and from New Zealand called "International Air Freight Capacity" and "Maintaining International Air Connectivity". The former ran until March 2023. These programs provide a predictable and regular schedule of air services to maintain New Zealand's international connectivity to key markets. Exporters can access flights through freight forwarders.

III.6.2. Promoting new marketing or sales channels

As the marketing stage of the AVC was severely affected by the pandemic, governments in the region applied external strategies to facilitate the farmers' access to new markets and the consumption of seafood products. Additionally, promoting digitalization and e-commerce contributed to this goal ([See Section III.8.](#)).

In the Philippines, through the program "Seafood Kadiwa ni Ani at Kita on Wheels" (FAO, 2020c) the BFAR facilitated assistance by linking fish producers to markets outside of their municipality, such as mobile or open markets, helping to stabilize food supply, which was perceived as very helpful by fish farmers and fishers (Manlosa et al., 2021). The program has continued in 2021 and 2022.

In Thailand, a policy to set up product distribution points at local markets, department stores, retail shops, and gas stations was introduced in each of the 23 coastal provinces, including 17 provinces along the Gulf of Thailand coast and 6 provinces along the Andaman Sea coast. The Department of Fisheries (DOF) under the Ministry of Agriculture and Cooperatives carried out the policy to provide suitable selling outlets for artisanal fishers while also improving their salesmanship, processing, and packing skills. This not only increases product publicity but also raises the value and precious images of the products in the future. This led to initiating the project "The artisanal fishery product distribution to consumers at Fisherman Market".

Fisherman market events held in central and regional areas have been extremely successful in marketing the products of artisanal fishermen. Establishment of a new marketing channel named "Fisherman Shop" by DOF in 77 provinces all over the country to upgrade the distribution channels of artisanal fishery products and develop the marketing skills of the fishers. Additionally, the Fisherman Shops serve as a centre for public relations and brand awareness for farmers, artisanal fishers, micro, and small-scale enterprise groups, and entrepreneurs under the supervision of the DOF. Moreover, Fisherman Shops support and promote the development of value-added products and packages as well as logistics and transportation to ensure that the products are fresh, clean, standardized, safe, and environmental-friendly by using the "Green Flag Fisheries" label.

III.6.3. Temporary removal of fish production: the importance of cold storage facilities

Changes in demand for fish products led to increased food waste and losses. Some fish farmers used to sell to the HORECA adopted the coping strategy to keep their fish alive or to stock their products, mainly by freezing them, in the hope of selling them shortly afterwards. However, as demand did not recover quickly enough, they also had to find alternative market channels. Temporary withdrawal of fish production from the market was mandatory to reduce loss and waste of fish products, and increasing cold storage was an important strategy for aquaculture products where demand had decreased but production could not be easily slowed or stopped.

In Indonesia, and the Warehouse Receipt Program contributed to ensuring the preservation of fish products during the low demand periods (Maruff, 2020). In August 2020, the MMAF launched this program through which fishers could store their catch in designated cold storage facilities and receive a receipt to use as collateral for the bank-backed loan (up to 70% of their catches' value) at 6% annual interest. This initiative was designed to address the shortage of cold storage capacity caused by the decline in export demand.

One of the lessons from the pandemic is that sufficient cold storage capacity could mitigate major demand constraints, according to an interview with a leading Filipino scientist: *"The government should also build infrastructures such as cold storage and processing plants in the top fish- and aquaculture-producing provinces or cities to preserve the products and extend their shelf life. These facilities are only available in metropolitan areas like Manila, Cebu, or Davao."* The interviewee from Chinese Taipei mentioned that a better cold chain is currently under construction in the island and enhancing the cold chain and frozen sector would help to avoid price crash if certain species are overproduced.

In Chinese Taipei, the government launched the COVID Relief Stimulus 4.0 program, which provided incentives for processed, canned and preserved fishery products to benefit food producers that needed to use storage facilities for their products for more than one year at 6-15 yuan/unit. Moreover, the development of products such as cans is being encouraged, while maintaining the quality control.

III.6.4. Promoting seafood consumption and institutional seafood purchasing

Promoting domestic seafood consumption was taken by some APEC economies including Australia; Indonesia; Japan; Peru, and Thailand. Another measure taken by governments was the institutional purchase of seafood, which had two main benefits in combating the effects of the pandemic, first to absorb the fishery/aquaculture products when farmers had difficulty marketing their products, and second, to help alleviate hunger. In addition, some local governments bought fish to include it in the food distribution to families affected by quarantines. These measures are listed in Table 9.

Table 9. Selected supply chain and marketing measures implemented by APEC economies to support aquaculture in response to the COVID-19 pandemic.

Australia

- ⑤ The Eat Seafood Australia, a 12-month awareness campaign in support of the seafood sector, a AUD4 million program that encouraged the consumption of sustainable Australian seafood (2021-2022).

<ul style="list-style-type: none"> ☞ General measure - “<u>IFAM</u>” which facilitated the export of high-value perishable products (including seafood products such as lobster) to international markets, as well as the import of goods with subsidized air freights (April 2020-September 2022).
<p>Canada</p> <ul style="list-style-type: none"> ☞ The <u>Surplus Food Rescue Program</u> enabled the management and redistribution of existing food surpluses to organizations addressing food insecurity and ensuring that these surplus products were not wasted. The program was designed to address high volume, highly perishable surplus products including fish and seafood.
<p>Chile</p> <ul style="list-style-type: none"> ☞ Resolutions were adopted to extend the stocking period, facilitate the shipment of samples as part of disease surveillance programs, and extend the time fish can remain in the water and in storage facilities.
<p>Indonesia</p> <ul style="list-style-type: none"> ☞ Assistance to fishers and fish farmers in the provision of food, personal protective equipment, portable and mobile cold storage, ice makers machines and others. ☞ Cool boxes were distributed to fishmongers and collectors to improve the implementation of the cool chain ☞ Institutional purchase of seafood products by the <u>Disaster Care Program</u> and inclusion of fish in food packages (e.g., “Program Keluarga Harapan”, “Bantuan Pangan Non Tunai”). ☞ Promotion of aquaculture through the provision of seeds, seedlings, broodstock, feed, pond revitalization, cold chain facilities and support to affected actors.
<p>Japan</p> <ul style="list-style-type: none"> ☞ Access to continuous data on cold storage capacity created by the Japan Association of Refrigerated Warehouse Association for businesses that were forced to consider implementing frozen storage. ☞ Promotion of local demand by the <u>Go to Eat Campaign</u>, which aims to stimulate local demand for a limited period of time through public-private integration in the food industry.
<p>Malaysia</p> <ul style="list-style-type: none"> ☞ Malaysia allocated MYR100 million (USD25 million) to develop food storage and distribution infrastructure (Ferrer et al., 2021). ☞ Promote access to new markets through the establishment of alternative marketing and distribution channels such as controlled fresh markets in locations accessible to the public.
<p>New Zealand</p> <ul style="list-style-type: none"> ☞ <u>International Airfreight Capacity</u> and <u>Maintaining International Air Connectivity</u>, government support for airfreight to maintain international routes for high-value products that suffered disproportionately from the collapse of air travel (May 2021-March 2023).
<p>Peru</p> <ul style="list-style-type: none"> ☞ The economy wide program “A Comer Pescado” included open mobile fairs (wet markets) known as “Mi pescaderia”.
<p>The Philippines</p>

- ☞ The program “Seafood Kadiwa ni Ani at Kita on Wheels” (FAO, 2020c) facilitated assistance by linking fish producers to markets outside of their municipality, such as mobile or open markets.

Chinese Taipei

- ☞ Subsidy to transportation fees to overseas market (grouper and tilapia), subsidy for drug residue examination and drug testing during the manufacturing process, subsidies for packaging materials, processing, frozen storage and canning.
- ☞ Help to obtain Aquaculture Stewardship Council (ASC) certification (for grouper), help open overseas market for ornamental fish, grouper, tilapia and soft shelled turtle.
- ☞ Help to develop new international markets, such as Singapore and accelerate sales domestically.

Thailand

- ☞ Promote access to new markets through the establishment of distribution channels for the domestic consumption of fish products and the temporary creation of a seafood marketplace.
- ☞ Promote local markets through the program “Fisheries Shop” in zero-Covid areas.

The United States

- ☞ The Agricultural Marketing Service purchased a variety of fruits, vegetables, meat, dairy and seafood products. Food was provided to USDA Food and Nutrition assistance programs, including food banks

III.7. Management and technical measures

Several strategies were adopted by aquaculture farmers worldwide to cope with the initial shock of the pandemic: low densities, the introduction of new aquaculture species, staggering harvest over different periods and increasing varieties of high-value species (Lebel et al., 2021; Mangano et al., 2022). In the Mekong region (including Thailand and Viet Nam), the most common coping farming strategies (seen in June-August 2020) included adjusting stocking rates, reducing labor inputs, using savings, and borrowing money (Lebel et al., 2021). Chumchuen et al., (2022) found that in Thailand more than 70% of small-scale farmers in the crab, fish and shrimp industries reported that they have adapted their farming activities mainly by delaying stocking and to a lesser by reducing stock density, some farmers in the study even opted to sell all of their production immediately, despite of low profits, during the early stages of the COVID-19 pandemic and before the market collapse. The shrimp farming industry in Thailand was advised to reduce their production by 50% due to the expected low demand for shrimp as most consumers choose cheaper protein sources (Kaewnuratchadasorn et al., 2020).

In Indonesia, the main strategies for the recovery of aquaculture business in Magelang were: increasing production capacity, digitalization, increasing the frequency of mentoring and group development by the government, improving product quality, business diversification, proportionality of the number cultivators in the hatchery and rearing segment, providing education to farmers regarding the impact of COVID-19, strengthening capital, expanding the implementation of the Independent Fish Feed Movement program, protecting the farmers, and strengthening of market access (Rochvita et al., 2021).

III.8. Promoting digitalization, innovation and sustainability

III.8.1. COVID-19 and aquaculture leap into e-commerce

The pandemic has accelerated the diffusion of e-commerce and delivery intermediaries in the food industry, allowing companies to make their supply chains more resilient, at least temporarily, and hopefully in the long term. Digitalization of the marketing stage of the AVC was one of the most applied and effective solutions to withstand the pandemic. Stakeholders’ studies

in China reported that the most immediate measures applied by processing plants to cope with the pandemic were to improve processing technology, produce high-value products, and increase e-commerce and online sales (Yuan et al., 2022). This strategy was probably severely limited in Papua New Guinea given the low level of Internet access¹⁹ in the economy, 12% in 2020, well below the APEC regional average of 74% (APEC, 2022). In such cases, a more fundamental goal should be pursued: increase Internet access for the general population, before making major investments in massive digital sites or technologies.

During the COVID-19 pandemic, several APEC economies introduced or strengthened measures to promote the e-commerce in seafood products:

- ④ The Local Catch Network, created by The University of Maine, linked its members to direct seafood products sales in the US and Canada.
- ④ Thailand set aside a budget to develop an e-commerce platform, where fishers and fish farmers could sell their products and have direct contact with customers without having to deal with middle persons. The budget included the construction of eight distribution centres for fisheries products, including storage and transportation to support the new e-commerce site (Maruff, 2020; SEAFDEC, 2022b).
- ④ Instead of building a government-run e-commerce platform, the MMAF in Indonesia, chose to build the website, www.pasarlautindonesia.id, which enables and facilitates fisheries SMEs to join existing e-commerce sites such as Shopee, Lazada, Tokopedia, Gojek and Grab (Maruff, 2020).

The reliance on the domestic market has declined as export markets reopened, however the e-commerce platforms and digital marketplace for domestic market access are likely here to stay and can even be expanded to regional and global markets. Industries and governments should be aware that this increases the risk of unsustainable, unregulated, and unreported seafood entering domestic markets. One proposed solution is **to link these digital marketplaces to government systems to issue compliance and verification certificates** (Maruff, 2020).

III.8.2. COVID-19 and the prospect to accelerating e-governance

The pandemic has also served as an **opportunity to simplify and digitalize licensing systems, certificates, processes and even establish remote monitoring** in fisheries and aquaculture related agencies in economies that had not adopted such technologies.

- ④ In Indonesia, the government simplified and digitalized licensing across 38 Ministries, including the MMAF, which is now fully consolidated under the Indonesian Investment Board. The MMAF has improved its online licensing system, SILAT, which is managed by the Directorate of Capture Fisheries, to process licenses within one hour, which previously took four days (Maruff, 2020).
- ④ In Chile, all documents that would normally be received at SERNAPESCA were allowed to be delivered through electronically and remote health monitoring was installed. As mentioned during the interview: *“The digital part was the best of the pandemic, it was the unexpected result, everything has already become digital, inspections are even done remotely. There was a lot of interest from officials to learn and train, even officials who were not from the technical areas, to be able to support. The online world allowed more and more meetings with the competent authorities in a very short time.”*
- ④ The processes were digitalized through the Mexican Fisheries and Aquaculture Information System (SIPESCA).
- ④ The Peruvian Agency for Fisheries Health (SANIPES) introduced the issuance of export certificates with digital signatures and QR codes, for hydrobiological products. During the interview with the representative from the Peruvian Ministry of Production they listed several actions taken to increase e-governance such as: *CREDIPES*, a smartphone application to facilitate the access of fish-farmers to different credits, developed by FONDEPES. Moreover, the Peruvian Program for Innovation in Fisheries and Aquaculture (PNIPA) implemented the SAPEL application, that allowed digital management of processes, including monitoring, related to the innovation grants for the fisheries and aquaculture sectors offered by the institution.

¹⁹ Measured as the % of total population that used the internet on any device at least once in the past three months.

III.8.3. Using the momentum to accelerate the adoption of innovative technologies for aquaculture

The experience of accelerated digitalization during the pandemic can be used to increase the rate of adoption of innovative technologies for aquaculture. Innovation can increase the sustainability components of aquaculture to meet the opportunities arising from the COVID-19 pandemic (Galanakis et al., 2021). For example, digital farming or precision farming and IoT-based solutions can minimize human contact and labor constraints during lockdown periods, facilitate traceability programs and data-driven decision making, and subsequently increase the productivity and sustainability of aquaculture (Maruff, 2020; Jamwal & Phulia, 2021). However, the extent to which smallholder farmers could gain access to such advanced technologies, which require more complex skills, is probably very limited for most developing economies and needs further evaluation (Salajegheh et al., 2022).

Experiences from Indonesia indicate that new programs aimed to promoting innovation and digitalization for SSA alone are not enough, and such programs should include effective communication campaigns, since most small-scale fish farmers have very little interest in using them (Box 7).

Box 7. Experiences with digitalization and innovation in SSA in Indonesia.

Interview with: Mr. Hatim Albasri from the Research Center for Fisheries Agency for Research and Innovation, Indonesia.

Digitalization of aquaculture in farming activities is still low in Indonesia, most of them are still in the research stages. Some startup companies, such as “e-fishery”, have developed robust water quality monitoring systems, automatic feeding and several other innovations in aquaculture. “*However, the cost of running the system, including licensing, is just too expensive for small-scale fish farmers.*” Mr. Albasri led a research program in cooperation with Japan called “SATREPS Mariculture”, a five-year program (2016-2021) to try to introduce digitalization and innovation in marine culture and capture:

“We have developed several digitalization systems such as real-time water quality monitoring system, digitalization of operational records, display viewer for water quality and educational and training platform. Despite the system working perfectly and being free of charge, fish farmers have very little interest in using it due to their strong attachment to their local and personal knowledge-based experience.”

Several market and traceability systems were developed by the MMAF as part of the effort to digitalize the market system and improve traceability. An application called “STELINA” for the fish traceability and stock system was launched in 2018 by MMAF. This was a collaboration between USAID Oceans, MMAF, Indonesian local governments, private sector and non-governmental partners to develop and implement an electronic catch documentation and traceability system in the program’s learning site of Bitung, Indonesia.

“However, the rate of use and voluntary reports were relatively minimal, and thus, the Ministry still relies on manual data records to supply the application with recent and complete data regarding the production and traceability of aquaculture products.”

In the case of small island developed economies the pandemic has increased the awareness of the importance of innovation for aquaculture development and ultimately for food security.

- In Singapore, during the COVID-19 pandemic, the government added SGD30 million (USD21 million) to a 2019 program designed to increase food self-sufficiency from 10% to 30% by 2030, commonly called the “Singapore Food Story”. The money was used to rapidly increase the production of vegetables, eggs and fish by local farms in the shortest time possible (Teng, 2020). Ensuring food security can be especially problematic in small island economies like Singapore, where self-sufficiency is limited by the availability of land, fresh water and labor. Aquaculture can contribute to such a goal in these economies through innovative technologies.

- In late 2020, Hong Kong, China, adopted a similar approach with the "Accredited Fish Farm Scheme" to promote the sustainable development of the local aquaculture industry. This program aims to increase the contribution of local seafood consumption by providing technical assistance, regular visits and sampling, complementary veterinary services, strong product traceability, a platform for business opportunities and opportunities to participate in exhibitions and trade shows²⁰.

For government-sponsored projects to succeed, there must be integral oversight from the proposal to the final product development with ongoing support along the way. The government should consider providing technical assistance to the farmers interested in these production systems, especially when new concepts are being introduced. The government should provide funds to the farmers for them to attend training courses to better understand these new systems. Furthermore, financial assistance, such as loans with low interest rates, should be provided to help them start their businesses. For new farmers, the government should first help them find and establish markets for their products.

III.8.4. Promoting sustainability and resilience

Prior to the COVID-19 crisis and its aftermath, aquaculture was already facing major challenges worldwide including diseases, natural disasters, environmental threats and social development. In some cases, COVID-19 has combined the effects of simultaneous stressors, including climate change, pollution, fish diseases, natural disasters and war (Sarà et al., 2022). In areas prone to natural disasters, the pandemic is perceived as less impactful than climate change or natural disasters (Rendón et al., 2021; Sarà et al., 2022). These factors will affect aquaculture once again in the future and the lessons of this crisis must be seen as an opportunity to change the future direction of the sector.

There is an increasing pressure worldwide on stakeholders, policymakers, industries and farmers, to adopt more sustainable policies, practices, and processes (Galanakis et al., 2021). **The pandemic has impacted the Paris Agreement's goals of "enhancing adaptive capacity", "strengthening resilience" and "reducing vulnerability" to climate change**, as economies have been forced to prioritize health and economic recovery (UNEP, 2021). This means that COVID-19 recovery plans should include an environmental component to support blue economic recovery. To cope with the increased risks and to enhance resilience of aquaculture systems, a range of different mitigation measures should be applied.

During the workshop developed as part of this project, Mr. Xinhua Yuan, Deputy Director of the Fisheries and Aquaculture Division, FAO shared recommendations from FAO for the development of blue economy plans. Governments are encouraged to line up their plans to the global food system transformation, a program from the United Nations, including the FAO strategy framework 2022-2031: "Better production, better nutrition, better environment", better life, leave no one behind" and the "Blue transformation roadmap". Some of the main challenges pointed out by the speaker for this blue transformation were lack of concrete and actionable policy and governance, call for inclusive social security program for aquafarmers, business model innovation, efficient and quality input, climate change mitigation and adaptation and consumption driven vs production driven.

A set of recommendations for governments to meet the blue transformation goal in relation to the pandemic crisis were presented during the event including strengthening the disaster early-warning system and local capability of risk mitigation as well as supporting the development of modern trade/marketing methods for aquaculture products and needed infrastructure and others. Some suggested innovations were also highlighted such as better planning and zones to optimizing resource use, improving aquaculture engineering and the use of energy, diversify source of aquafeed ingredients, improved nutrition and feeding, application of biotechnology including nanotechnology, bioremediation and probiotics in effluents and pathogens management, promote use of digital and information and communication technology and adoption of aquatic biosecurity.

²⁰ Mark Godfrey. New fish farming standards designed to lift Hong Kong, China, aquaculture sector. 12 November 2020. Accessed: 18 January 2023. Available in: <https://www.seafoodsource.com/news/aquaculture/new-fish-farming-standards-designed-to-lift-hong-kong-s-aquaculture-sector>

One key strategy for the sustainability of the sector is to diversify the production, Kevin Heasman, a researcher from the Cawthron Institute in New Zealand provided insights into the benefits of diversifying farmed species:

“Most of the main species in NZ (King salmon, oysters, mussels) are investment intensive. Smaller players need to develop alternative species that require less upfront investment, or the development of cooperatives with a central supply/market hub with satellite grow-out options. This is not a traditional avenue of advancement for New Zealand and may have difficulty getting traction”

Another aspect is the diversification of markets. During the interview with the expert from Chinese Taipei, opening broader overseas markets was highlighted as the most important measure for the future of aquaculture in the island. In that regard, support from the government on taxes and export fees to the market outside of Chinese Taipei was proposed.

Resilience can be defined as the ability of a production system to respond and adapt to unexpected events while maintaining the same function and structure as before. Polyculture practices, including IMTA, aquaponics and integrated agriculture–aquaculture, can improve the resilience of aquaculture and among such systems IMTA farming has been shown to be more resilient to most of the effects observed during the COVID-19 pandemic (See Box-8) (Mangano et al., 2022). Nevertheless, IMTA systems are still an emerging technology in many economies, as highlighted in an interview, *“IMTA is an emerging technology in the Philippines. It is not a major aquaculture system used by the aquaculture sector. Where IMTA is being practiced, usually at the experimental level, not at the large-scale and commercial level”*.

Box 8. The aquaculture supply chain in the time of Covid-19 pandemic: Vulnerability, resilience, solutions and priorities at the global scale (Mangano et al., 2022).

A global digital survey (52 economies) was conducted on the perceptions of aquaculture stakeholders from different farming strategies (land-based or sea-based, intensive or extensive and IMTA systems) during the initial shock phase of the pandemic, 5-29 May 2020.

In this assessment, **IMTA systems were more resilient to most of the impacts observed during the COVID-19 pandemic**. IMTA stakeholders, from both land-based and sea-based, extensive and intensive farms, experienced proportionally less or no economic hardship during this phase, and statistically less or no impact on job losses, particularly in sea-based intensive systems. IMTA systems offer diversified products with more than one or two market options, which may have allowed farmers to take advantage of still-active sales channels and weather the pandemic.

Moreover, firing was a less common mitigation measure adopted by IMTA farmers, an important response from a social resilience perspective. Among external mitigation strategies, IMTA farmers expressed a higher interest in exploring new market strategies and direct sales, scientific support and supply chain promotion, while non-IMTA farmers expressed a higher preference for direct economic support from government agencies.

In general, farmers working with IMTA showed a preference for tools typical of “Flexible Business Models” which are considered one of the best mitigation strategies to cope with distribution risk. However, IMTA systems may be more vulnerable to external shocks at the hatchery stage, due to difficulties in seed availability, as they rely on seeds for different animal species.

The pandemic has shifted customers preferences and has accelerated pre-existing innovation trends. For example, strengthening the immune system has been a priority for consumers, a trend that has accelerated in the COVID-19 era, and consumers' interest in sustainable, healthy, organic, and functional foods has grown rapidly.

The Korean Ministry of Oceans and Fisheries announced, in December 2021, a Master Plan for the Management and Utilization of Marine Healing Resources to promote the marine healing industry. “Marine healing” refers to activities to improve the health of the people, such as improving constitution, enhancing immunity, and anti-aging through the use of marine healing resources. Over the next five years (until 2026), the master plan will lay the foundation for the marine healing industry and promote full-scale industrialization through R&D, the establishment of an integrated information system, professional training, the establishment of cooperative networks and the promotion of public awareness.

III.9. Promoting sex and gender equality

Concerted efforts are needed within the aquaculture sector to prevent the pandemic from reverting all the achieved progress towards gender equality. This will require the development of appropriate gender-sensitive mitigation strategies. Despite their importance, sex disaggregated data and gender-specific data were not systematically collected worldwide before COVID-19, and this has been exacerbated by the global pandemic. **Sex-disaggregated data and gender statistics are key to identify discrepancies between women and men during COVID-19**, and to making informed policy and development program decisions for people who depend on the aquaculture sector (Choudhury et al., 2022). To develop effective responses, women must also be a part of the decision-making process and this process must be supported by high-quality data and evidence-based solutions.

In 2021, Chile published a report about the status of men and women in the fisheries and aquaculture sector, showing that economy-wide, the sector is composed by 25% women and 75% men. The report included details of numerous gender disparities still present, however it also showed minor advances (Government of Chile, 2021). The development of similar tools should be considered across all APEC economies, and more importantly, sustain them in the long term, not only to map the status, but to monitor the effectiveness of actions and policies towards women’s equality in aquaculture.



IV. SECTION 4: CONCLUSIONS AND POLICY RECOMMENDATIONS

In this section, policy recommendations are formulated based on the lessons learned during the discussion of the previous main sections (including data from questionnaires, interviews, workshop and secondary sources). This, considering the most common disruptions seen during the pandemic ([See Key messages in Section II](#)) and the diversity of strategies designed to mitigate the challenges of COVID-19 in APEC economies ([See Key messages in Section III](#)). Recommendations are divided into **short-term or immediate** responses for future similar crises and **long-term transformative support** to ensure economic recovery and enhance the resilience and sustainability of aquaculture, particularly for SSA and vulnerable groups. A lasting change in the sector can only be achieved through the implementation of a mix of existing, reformulated and/or new policy mechanisms through an **integrated approach that includes financial, social and environmental actions**. Recovery strategies for SSA should follow the recommendations developed for the commemoration of the International Year of Artisanal Fisheries and Aquaculture in 2022 (IYAFA 2022, FAO, 2022b).

IV.1. Short-term mitigation recommendations

Immediate recommendations to mitigate the impact of future shocks similar to COVID-19, including future pandemics, on the SSA should seek to ensure that aquatic food value chains operate as close to “normal” as possible and provide emergency relief and financial support to small-scale farmers.



Ensure that the aquaculture industry is among essential and priority sectors as soon as possible. This was the most important response, and in some cases, it was not developed as fast as policy makers and farmers would have liked. Such policies were key to supporting the input supply, marketing, processing, import and export activities.

In cases where budgets for financial assistance are severely limited, fast and proper implementation of such actions were even more crucial.



Restrictions on the trade of seafood products should be avoided; if in place they should be reviewed as frequently as possible and lifted when sufficient scientific data indicate that they do not pose a health risk. These measures disrupted marketing channels for farmers even in areas where the COVID-19 pandemic did not affect the general population and contributed to customer panic.



Subsistence and small-scale companies should be the focus of support packages, as they are labor-intensive and account for the majority of aquatic food produced and have fewer contingency mechanisms. Fisheries and aquaculture specific packages should be considered according to the size of the sector, its specific characteristics (informality, associations, seasonality) and differential impacts compared to other economic sectors.



Eligibility criteria for cash transfers must include vulnerable groups including migrant workers, secondary industries workers, women and native communities. Informal farmers for example may be excluded if social security registration is required. Transparent, simple, and inclusive eligibility criteria need to be pursued.



Recovery policies should be regionally specific. COVID-19 significantly disrupted the spatial market integration of in areas with high infection rates, while less disruption was found in provinces with low infection rates, suggesting that supportive policies were most needed in such provinces (Wang et al., 2023).



Increase institutional purchases of seafood during such periods, which can be included in food aid packages and distributed through social programs to hospitals, schools or directly to the population, is a fast mechanism to absorb the stagnant production and mitigate income losses, particularly for fresh products, while also

ensuring livelihoods and food security with a highly nutritious, affordable and low carbon emission food source.



Ensure the automatic extension of visas for migrant workers during crises periods, particularly in the fisheries and secondary sectors. Governments must be aware of the contribution of migratory workers to their aquaculture sector.

IV.2. Long term support measures

The COVID-19 pandemic not only had a moderate to severe financial impact on aquaculture but has also reversed years of progress on key social indicators such as poverty, food and nutrition security and sex and gender equality, hence measures to promote economic recovery and improvement of social indicators were needed, and in some cases, are still needed. While not all APEC economies have been affected equally, nor have developed economic recovery programs, the pandemic represents a great opportunity for all economies to enhance the resilience and sustainability of the sector by highlighting weakness such as the heavy dependence on foreign markets, imported products, or weak social security coverage, and by identifying opportunities or accelerating trends such as local supply networks, open markets and digitalization.

To this end, this report sets out an action plan of long-term measures. The proposed measures are in line with the Aotearoa Plan of Action for the implementation of Putrajaya Vision 2040²¹, which was endorsed by APEC economies in 2021, and emphasizes the importance of Promoting Innovation and Digitalization; Strong, Balanced, Secure, Sustainable and Inclusive Growth, through the development of resilient supply chains.

Increase the knowledge of the status and future of aquaculture



Develop micro-regional and economy-wide studies on the status of the aquaculture. Prior to any intervention, knowledge of the current situation of the sector including socioeconomic data and stakeholders' perception is key to formulate effective actions and policies for aquaculture. Special attention to the situation of small-scale farmers to address their needs and the inclusion of sex-disaggregated data are imperative. The government must take the initiative to establish a broad, solid and permanent collaboration with the private sectors, academia, international agencies and local communities, so that all entities contribute to this goal.



Elaborate an economy-wide strategy plan for the development of aquaculture. This must be formulated together with the actors of each economy and implemented as a state policy with a long-term vision. Measures to support aquaculture should align with these objectives.

Strengthening the governance of the sector



Improve the database development and transparency on small-scale aquaculture official data and its quality and accessibility. There is a need for better access to productive and socioeconomic data in seafood from government organizations. Public data has been used by decision-makers as a reliable database of current workers eligible for emergency relief funds, and in some cases, discrepancies in such databases have left people in need without the much-needed income support, while those who were less in need received economic relief packages.



Consolidate interinstitutional and intersectoral work to maintain a permanent fishery-aquaculture governance. Regular and fluid interaction between aquaculture stakeholders, including government, relevant aquaculture organizations/associations, and farmers is essential to quickly identify emerging issues and establish consensual actions to promote the health and secure the work of aquaculture farmers. Strong cross-sectoral engagement and co-learning can help to develop more inclusive policies.

²¹ Asia-Pacific Economic Cooperation. Accessed: 17 January 2023. Available in: <https://aotearoaplanofaction.apec.org/#:~:text=The%20Putrajaya%20Vision%202040%20will,implementing%20the%20Putrajaya%20Vision%202040.>



Vulnerable groups need to be identified and consulted in the design of public policies. Economies produce and consume fewer aquatic products when wealth, formal education and voice and accountability are lacking. Public policies in aquatic food systems from around the globe do not sufficiently address political and gender-based barriers.



Digitalization of tools for e-governance, the simplification and digitalization of licensing procedures, sanitary certificates, meetings, introduction of remote inspection and increasing traceability of products were among the positive outcomes of the pandemic and should be followed or expanded by economies. Promoting digitalization in the sector does not mean banning non-digital options.



Create emergency protocols for unforeseen external shocks, such protocols would allow immediate response capacity to avoid this suspension of activities that was so harmful to many producers. The protocols should specify the competencies of each government agency.

Building capacity and empowering small-scale farmers



Design an economy-wide strategy to promote strong, empowered and sustainable SSA farmers' associations. Aquaculture is dominated by small-scale producers in most economies; however, their size and lack of resources have limited their opportunities in many ways, especially in accessing financial resources during the pandemic. This can be improved in the future through association. Association has countless benefits for small-scale aquaculture enterprises, can facilitate collaboration with government in policy making, facilitate the access to credit, facilitate the communication with academic institutions, NGOs and input providers, accelerate technology transfers, among others. The FAO Fisheries and Technical Paper N°655 developed in 2020 can be used as a guide to promote such an objective in developing APEC economies (Hassan et al., 2020).



Expansion of social security and protection systems for fisheries and aquaculture workers. In the long term, broader and more inclusive coverage of social protection systems will be key to ensuring livelihoods and food and nutrition security. Changes to regular social security schemes should include, where possible, increasing coverage, relaxing eligibility, benefit values, program duration or introducing extraordinary payments when needed.

Promotion of seafood consumption and adoption of new customers trends



Economy-wide, regional and local communication campaigns to promote local seafood consumption can help to diversify markets and avoid excessive dependence on exports, while offering highly nutritious and low environmental impact products, contributing to food security.



Developing seals and certificates for seafood products, including for local production. Seals for products from SSA would line-up perfectly with effective communication campaigns for the promotion of local seafood consumption. Furthermore, the risk of seafood spoilage during transport can deter customers from buying online. Labels and certificates that guarantee safety and quality of fish can help to increase the consumption of fish products in digital markets.



Governments could **support aquaculture farmers to meet and market their products in line with current customer trends,** exacerbated by the pandemic, for bioactive compounds, immune-enhancing products, alternative protein sources, processed or ready to cook items and marketize their products accordingly. Experiences like Korea's "Master Plan for the Management and Utilization of Marine Healing Resource" go in that direction.

Building a new momentum for the digital transformation of aquaculture



By supporting the creation of digital market channels or facilitating farmers' access to available digital marketing channels, digital trade has clearly strengthened the aquaculture supply chain, increasing its resilience while contributing to food security.



Provide training to support the digitalization of aquaculture to facilitate advertising, marketing, delivery of technical advice and payments. The search for new marketing channels and especially e-commerce was the most frequently used tool to cope with the effects of the pandemic. Tools such as digitization, and automation have the potential to mitigate the impact of future food security risks.



Promote the digitalization of SSA with low-tech technologies. Digital transformation should recognize that some households cannot afford Internet service or digital devices, others may have difficulty in using new technologies and that the older generation may feel left behind if they are unable to keep-up with new digital and high-tech business models. Therefore, alternative non-digital resources must be ready and available in such cases.

Promoting diversification, innovation and advanced aquaculture technology



Supporting the development of sufficient cold storage in susceptible fish production areas, to adequately manage market supply and demand disruptions and to preserve fish products, whether frozen or in other processed forms, until the market improves. Research will be needed to identify the most vulnerable areas for such investments in each economy.



Promote the diversification of aquaculture operations, including species farmed, value added, diversified markets and competitiveness, to maximize the value of their products and maintain a sustainable business. Diversification of the aquaculture sector in terms of species or technologies requires incentives from governments, particularly in economies that are heavily dependent on few species for most of their production. Authorities can take different approaches to achieve this goal, either by applying regulations that make current applied technologies more expensive than the new ones (e.g. limits or taxes on the discharges) for those with the greatest environmental impact or by subsidizing cleaner technologies.



Promote innovation and advanced aquaculture technologies, from the basic ones such as better animal health management through vaccination and adoption of disease resistant strains, up to more complex ones such as remote and real-time digital monitoring and auto-feeding. Digitalization and innovation are the future of aquaculture, they can increase production efficiency and profits. However, the awareness of fish farmers, especially small-scale fish farmers, must be increased to ensure high acceptance and use of digital fish farming and similar more complex technologies.

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ANNEX

Annex 1: Research report summary

The initial research report was prepared by collecting systematically data from primary sources (responses to a digital questionnaire and interviews) and secondary sources (most relevant literature). There were nine responses to the digital questionnaire from eight different APEC economies (Australia; Chile; Hong Kong, China, Japan; New Zealand; Peru; Chinese Taipei and Thailand), two responses from Australia were received. Responses were submitted by official government representatives from each economy. Later, nine virtual interviews were conducted with experts in the aquaculture sector, including policy makers, intergovernmental officials, scientists, and government representatives from nine economies including: Chile; Indonesia; Mexico; New Zealand; Peru; the Philippines; Chinese Taipei; Thailand and Singapore. A total of 84 technical and scientific documents were consulted and are referenced in the present report.

This first analysis of impacts and initiatives allowed to classify the main effects of the COVID-19 pandemic on the aquaculture sector into: labor disruptions, supply chains and production disruptions, market demand and price disruptions, financial disruptions, impacts on seafood consumption and exacerbation of sex and gender inequalities. Meanwhile, the main policy mechanisms implemented by APEC governments was grouped into health and safety measures, financial measures, social protection and employment responses, supply chain and marketing measures, management and technical measures and promoting digitalization innovation and sustainability.

Finally, the initial research report guided the division of topics into four components:

- Section 1: State of the aquaculture sector in the APEC region
- Section 2: Major disruptions of COVID-19 in the aquaculture value chain
- Section 3: Policy mapping of actions taken by APEC economies to support aquaculture
- Section 4: Conclusions and policy recommendations

Among the main findings of the first section, it was evidenced that the aquaculture sector in the APEC region experienced the lowest growth rate (1.6%) in the past decade in 2020. The aquaculture industries of APEC economies were not equally affected by the pandemic and the most affected economies were Canada; Chile; Peru; Indonesia; the US and Singapore. On the other hand, the aquaculture sector in Australia; Brunei Darussalam; China; Malaysia and Russia showed no major impact of the pandemic. Finally, most of the exports of seafood products decreased in APEC economies in 2020, except for Brunei Darussalam and Indonesia.

The second section showed that there is an urgent need to develop micro-regional and economy-wide studies on the recovery process of the aquaculture sector after the pandemic (2021 and 2022 data). The impact of the pandemic was uneven across APEC economies and production systems, even within the same economy. The first major disruption caused by the pandemic was related to labor with employment and production expenses in the processing sector hit the hardest. The transport/logistics and market stages of the AVC were the most affected, which in turned caused decrease in demand and increase in production costs. Aquatic food consumption declined heavily in the initial stages of the pandemic and the consumption of local and processed seafood has increased. Digital sales and expansion of e-commerce were among the most used tools by fish farmers to access new markets. The aquaculture sector started to recover from these major constraints in 2021.

The main goal of the measures introduced by governments within the context of the COVID-19 pandemic were to protect public health in the industry, ensure the basic livelihood and maintain the supply chain operative. The economic support was the number one measure requested by aquaculture farmers worldwide, including in APEC economies. However, the high informality and lack of social protection of SSA enterprises in developing economies made it difficult for some of these actors to access economic support packages, mostly small actors from the informal sector. General economic relief packages in developing economies were introduced mostly in the form of low interest credits and loans for SMEs. While in developed APEC economies, such as Canada; Japan; New Zealand and the US, general and fisheries sector-specific economic compensation for the extra costs for the pandemic response were introduced in various forms,

particularly for the processing sector, the most affected sector. Measures to secure the aquaculture supply chain and to promote new markets were the most frequently adopted measures, particularly in cases where budgets were severely limited. The institutional purchase of food and the promotion of seafood consumption contributed significantly to absorb stagnant production. The positive aspects of the pandemic were the acceleration of trends towards digitalization and e-governance within fisheries and aquaculture government agencies.

Annex 2: Methodology

Quantitative and qualitative data on the impact of COVID-19 on aquaculture systems and policy mapping for economic recovery were collected from all 21 APEC economies through primary and secondary sources.

Primary Source

Initially, a digital questionnaire with 22 structured questions was designed to collect information from official regulators of the aquaculture sector. Later, nine virtual interviews with 7-10 semi-structured questions were conducted with various professionals in the aquaculture sector, including intergovernmental officials, scientists, and government representatives. The questions were designed using the FAO guideline: "Best practices for developing surveys and questionnaires on the impacts of COVID-19 on fisheries and aquaculture" (FAO, 2020a). The designed questionnaire can be seen in [Annex 3](#). The complete list of respondents for both instruments is shown in [Annex 4](#) and summarised responses to the interviews questions can be seen in [Annex 5](#). The questionnaire and interview questions covered two main subjects: 1) impacts of COVID-19; 2) mitigation measures implemented to cope with the impacts.

Secondary Source

The above information outlined the search for secondary data. This study included a systematic review approach for the most relevant literature. Reports and literature were reviewed to shape the framework, identify sector disruptions, and map policies. The inclusion criteria were: (1) documents in English; (2) published after January 1, 2020 (when necessary for specific concepts, articles with earlier publication dates were consulted); (3) related to the impact of COVID-19 and/or mitigation policies on the aquaculture sector. Keywords included: fisheries, aquaculture, COVID-19, public policy, and economic impacts. Various keywords were entered according to the research objective, and the operators 'AND' and 'OR' were intentionally used to expand the search. The reviewed literature included:

- 🌀 Research and review academic papers from the most extensive databases: ScienceDirect, Web of Science, EBSCO, Scopus, Taylor & Francis, Wiley and Google Scholar.
- 🌀 Reports, databases, and gray literature from the websites of intergovernmental and international organizations such as: FAO, UN, ILO, World Bank, OECD, World Integrated Trade Solution, INFOFISH, GLOBEFISH, WorldFish, SEAFDEC, OFWG, USDA.
- 🌀 Reports and gray literature from websites of official governmental sources.
- 🌀 Official press releases and newspaper articles were used only to track specific actions implemented by governments in the APEC region.

Publications with a global or regional (Asia, the Americas and Oceania) perspective on the subject were included, as well as documents containing any information related to one or more of the 21 APEC economies. Specific data from outside the APEC region was, for the most part excluded.

Quantitative Data

Quantitative data were obtained primarily from the following international databases: FishStatJ (FAO), OECD Agricultural Statistics, World Bank, and World Integrated Trade Solution (World Bank). Data from these sources only covered the first year of the pandemic (2020); therefore, data for 2021 were obtained from government agencies and market reporting companies where available. Socio-economic data were extracted over a period of 10 years (2010–2020). Data were grouped as: total aquaculture sector, ISSCAAP division for grouped species (aquatic plants, fishes, crustaceans, mollusks, and other animals), and selected species (tilapia, salmonids). Species representing 90% of the production volume for each economy were included. Note: A species' production volume is only recorded by FAO if it is greater than 0.5 T; therefore, production volumes below 0.5 T are recorded as 0.

Data from all 21 APEC economies were combined for comparison with other regions including Africa, the Americas, Europe, Asia, and the world, to determine the trends followed by each one. Additionally, economies were categorized for comparison based on income levels (World Bank classification) and production volumes/values.

Annex 3: Digital questionnaire

1. Indicate your full name, institution, and economy that you represent.
2. Indicate the institution and position in the institution that you represent.
3. Sex (female/male).

IMPACTS AND DISRUPTIONS

4. How did the aquaculture sector in your economy perform during the year 2020?
 - A. Reduced significantly
 - B. Reduced slightly
 - C. Unchanged
 - D. Increased slightly
 - E. Increased significantly
 - F. Not sure
5. How did the aquaculture sector in your economy perform during the year 2021?
 - A. Reduced significantly
 - B. Reduced slightly
 - C. Unchanged
 - D. Increased slightly
 - E. Increased significantly
 - F. Not sure
6. What was the variation (%) in overall aquaculture production (by value) in your economy during the period 2020-2021? Guesstimate is welcome.
7. How does your economy define the concept of small-scale aquaculture?
8. What is the current proportion of small-scale aquaculture (considered in the present questionnaire as rural aquaculture, including aquaculture for subsistence and artisanal aquaculture) in your economy? Guesstimate is welcome.
 - A. <25%
 - B. 25-50%
 - C. 50-75%
 - D. >75%
 - E. Not sure
9. Do you consider that small-scale aquaculture was more affected by the COVID-19 pandemic? If yes, please mention the three main problems found in this sector.
 - A. Yes
 - B. No
 - C. Not sure
10. Please rate the intensity of the following impacts derived from the COVID-19 pandemic and related restrictions for small-scale aquaculture in your economy? Please rate from 0-5. 0- no negative effect 1-slight effect 2-small effect 3-moderate effect 4-severe effect 5-catastrophic effect

Supply chain disruption	0-5
Restrictions of imports/exports	0-5
Drop demand and price variation	0-5
Labor shortage	0-5
Lower seafood consumption	0-5
Amplification of sex and gender inequity	0-5

REACTION AND POLICY MECHANISMS

11. Which group of measures has your economy implemented to assist the aquaculture sector during and post COVID-19 pandemic and when were they first implemented? *Yes, no, not sure and quarter of 2020.*
 - Health and safety responses
 - Financial assistance
 - Social protection
 - Management guides and technical measures
 - Promotion of digitalization
 - Promotion of innovation
12. When was the aquaculture sector of your economy exempted from COVID-19 suppression policies (lockdown measures)?
 - A. First quarter of 2020
 - B. Second quarter of 2020

- C. Third quarter of 2020
 - D. Fourth quarter of 2020
 - E. It was never included in the lockdown measures
 - F. Not sure
13. When were specific COVID-19 biosecurity and sanitization measures (disinfection and work protocols) for the aquaculture sector first implemented in your economy?
- A. First quarter of 2020
 - B. Second quarter of 2020
 - C. Third quarter of 2020
 - D. Fourth quarter of 2020
 - E. None of the above
 - F. Not sure
14. Please indicate if the following measures were taken within your economy to mitigate the effects of the COVID-19 pandemic in the aquaculture sector and rate the suspected impacts (strong, moderate, low, not implemented).
- Financial assistance
 - Expansion of social protection coverage
 - Support for access to new markets
 - Direct food distribution
 - Input subsidies (ice, fuel, etc.)
 - Promotion of local consumption of seafood
 - Purchase of seafood for institutional use
15. Have regulatory burdens been reduced for the commercialization of aquaculture products after the beginning of the COVID-19 Pandemic? If yes, please mention them.
- A. Yes
 - B. No
 - C. Not sure
16. Were actions to accelerate digitalization of small-scale aquaculture implemented in response to the COVID-19 pandemic? If yes, please mention them.
- A. Yes
 - B. No
 - C. Not sure
17. Were actions to encourage processing plants and fish farmers to develop new products implemented in your economy in response to the COVID-19 pandemic? If yes, please mention them.
- A. Yes
 - B. No
 - C. Not sure
18. Were specific mitigation and recovery measures for vulnerable groups (women, subsistence farmers, rural workers, migrants) to the effects of the pandemic within the aquaculture sector applied in your economy? If yes, please mention them.
- A. Yes
 - B. No
 - C. Not sure
19. Have specific policy frameworks to increase aquaculture sustainability and resilience after the COVID-19 crisis been elaborated and applied in your economy?
- a. They were elaborated and are currently being applied
 - b. They were elaborated but have not been applied
 - c. They are currently being elaborated
 - d. Not elaborated/applied.
 - e. Not sure
20. In your opinion, which are the key measures to support economic recovery of small-scale aquaculture after the COVID-19 crisis? Multiple choice selection.
- A. Establish unrestricted logistics to ensure normal production
 - B. Direct financial assistance
 - C. Promotion of organizational development and insurance schemes
 - D. Expansion of social protection coverage
 - E. Accelerate digitalization and innovation
 - F. Other measures.

21. In your opinion, which are the key measures to increase the sustainability and resilience of small-scale aquaculture to future shocks like the COVID-19 crisis? Multiple choice selection.
- A. Promote organizational development and insurances schemes
 - B. Shift toward better management practices
 - C. Diversification of supply sources and marketing channels
 - D. Diversification of practices and farmed species
 - E. Accelerate digitalization and innovation
 - F. Other measures
22. Please summarize the main difficulties encountered in your economy when implementing measures, programs, or policies for the economic recovery of the small-scale aquaculture sector during the COVID-19 crisis? *Open question.*

Annex 4: List of respondents to the questionnaire and interviews

Names have been removed from the list to protect personal information.

Economy	Relevant position
QUESTIONNAIRE	
Australia	Director, Multilateral, Aquaculture and Recreational Fisheries, Department of Agriculture, Fisheries and Forestry
Australia	A/G Director - Multilateral, Aquaculture and Recreational Fishing, Department of Agriculture Fisheries and Forestry
Hong Kong, China	Agriculture, Fisheries and Conservation Department (AFCD), Hong Kong Special Administrative Region Government
Japan	Assistant Director, International Affairs Division, Fisheries Agency
New Zealand	Manager Aquaculture Strategy and Development
Peru	Director of the General Direction of Aquaculture, Ministry of Production
Chinese Taipei	Associate Professor, Chinese Taipei Ocean University
Thailand	Department of Fisheries, Fisheries Biologist
INTERVIEWS	
Chile	Officer for Fisheries and Aquaculture in Latin America and the Caribbean at FAO.
Indonesia	Research Center for Fisheries, Agency for Research and Innovation, Indonesia
Mexico and Latin America	Principal Officer of Fisheries in Aquaculture for Latin America and the Caribbean at FAO.
New Zealand	Principal Investigator Cawthron Institute
Peru	Director of the General Direction of Aquaculture, Ministry of Production
the Philippines	Scientist Aquaculture Department of the SEAFDEC
Chinese Taipei	Assistant Professor Chinese Taipei Ocean University.
Thailand	General Director, Centre on Integrated Rural Development for Asia and the Pacific (CIRDAP)
Singapore	Deputy Centre Temasek Polytechnic Aquaculture Innovation Centre

Annex 5. Summary of virtual interviews

The interviews are listed by the order in which were responded.

Annex 5.1: Virtual interview Chinese Taipei representative

1. Which aquaculture production systems have been more impacted by the COVID-19 pandemic and related mitigation measures in your economy?

Covid-19 situation was not that serious in Chinese Taipei, but there were some impacts from it due to the situation in China and Hong Kong, China, since we export mainly to these economies. There was a negative impact for market size grouper and fourfinger threadfin to sell/transport to China, according to the news, in 2020, the market price for grouper dropped 36%.

2. In your knowledge, what were the main measures applied by your economy that contributed to mitigate the outcomes of the COVID-19 pandemic on aquaculture?

There were programs to support financially such as direct subsidy to farmers NTD10000-30000 per person, subsidy if reducing culture amount, interest free loans for 1 year, subsidy for longer culturing period, help to obtain Aquaculture Stewardship Council (ASC) certification (for grouper), help open oversea market for ornamental fish, grouper, tilapia and soft shelled turtle, subsidy for transportation fee to overseas market (grouper and tilapia), subsidy for drug residue examination, loans to sellers if their selling amount fell 20%, money for grouper farmer if they awarded with Traceable Agricultural Products certification. Additionally, the Fisheries Agency have helped to develop new markets, such as Singapore. Stimulus for drug testing during the manufacturing process, subsidies for packaging materials, processing, frozen storage, canning, etc, as well as group meal materials for marketing, fish market transactions, and promotion of domestic and foreign activities. One of the major moves was to accelerate selling domestically, for instance, the production of grouper, from 15 March to 1 May increased by 54.8% compared with the same period last year and the price also increased by 0.4%, with an average price of NTD167 per kg. Similarly, for tilapia, milkfish, barramundi, Japanese seaperch, cobia, sweetfish, fourfinger threadfin, and white shrimp, although the price dropped by 5.9% compared with the same period last year, the transaction volume increased by 6.4%.

3. In your knowledge, what were the major challenges that small-scale aquaculture farmers encountered in your economy to access government support?

Some of the culture places are not registered due to some difficulties such as property belonging, land rents, unlicensed water sour, and the farmers who culture animals in such locations are not eligible to apply for subsidies. The law of registration for culture licenses should be properly scrutinized and reformed to solve this problem and the standards should be untightened.

4. Were programs to accelerate diversification, digitalization or innovation applied or boosted in your economy after the COVID-19 crisis?

Yes, I think market expansion and development are the most critical measures for it which will allow us not to rely on certain markets. Digitalization, and innovation such as IoT and AIoT are also under development, which will facilitate the production rate and save more resources in aquatic animal production. For the products, fish was majorly sold as whole fish and filet in Chinese Taipei, but a better cold chain is under construction and products such as cans are also encouraged for processing more fish production and maintaining quality control.

5. How could governments help to improve the response of vulnerable groups to the effects of the pandemic or similar stressors within the aquaculture sector?

To have regulations or assistance to secure their work, working hours, average salary rate. Additionally, there can be some programs to help them to acquire more techniques/skills for acquiring more job opportunities.

6. In your opinion, which were the best short- and long-term measures applied in your economy to deal with the impacts of the COVID-19 pandemic on aquaculture?

In my opinion, opening broader overseas markets would be the most important part for our aquaculture. So, the best long-term measures would be those programs which help the market expansion besides the main importer (China). And the best short-term measure would be the

support from the government on the tax and export fee to the market outside of Chinese Taipei (e.g. the US and Southeast Asian economies).

7. What could be the best response to accelerate transformations in the aquaculture sector of your economy to build sustainability and resilience?

The government must help to regulate the number and species of major farmed fish and shrimps to avoid price drop. Additionally, enhancing the cold chain and frozen sector would help to avoid price crash if certain species are overproduced. Again, opening new markets (instead of relying majorly on certain market or domestic demand would help more investment and profit in the future. I think it is important to re-evaluate the appropriateness of culturing aquatic animals in certain regions, such as those areas without good freshwater and seawater sources.

Annex 5.2: Virtual interview Mexico and Latin America representative

1. How severe was the impact of the pandemic on the aquaculture sector in Mexico and the Latin America region?

The overall impact was very severe, but we can talk about stages. The first phase was the first few months of extreme uncertainty. Specifically, in aquaculture, we saw first that fish farmers with export and import chains stopped their commercial activities because the flights were paralyzed. For local fish farmers, the arrival of inputs was limited, as was their marketing. Aquaculture was slowly recognized as an essential activity, but there were efforts in some economies, such as Ecuador, to consider granting safe-passes and thus commercial activity began to reactivate. In many cases, aquatic organisms were still in culture or had to be harvested to avoid unnecessary mortality, or in other cases had to be stored and frozen, adding costs to the process. In a struggling economy, consumers had to absorb an initial increase in selling price. In other cases, there were also problems due to the lack of supervision in the cages, which led to robberies, among other direct consequences. In general, the commercialization of marine food shrank by 80%.

2. What were the main type of measures taken in the region?

There was no change in the soft credit policy. The immediate response was to include aquaculture as an essential activity, returning it to normal in terms of mobility, mobility of products and supplies, this was a measure that began to reactivate the industry. Over time, the resumption of flights also reactivated exports. This was followed by the sanitary inspection, a case of detection of COVID-19 in a package stopped that production batch and the exports themselves. Flights were reinstated and inspection began the reactivation. Small producers were more affected, as most do not have emergency capital to withstand months without sales. In some economies, the fisheries and aquaculture department began to design a response protocol, as was the case in Costa Rica. In other economies, such as Panama, social protection measures, such as food pantries were regularly offered during the first months as food did not arrive in rural areas. Response protocols are essential for future disasters. This was a fundamental lesson. In some cases, there are even exercises. What is the chain of authority for decision-making? Who is responsible for activating these procedures? These protocols must now be designed not for pandemics or external shocks, but for "normal" times.

3. Do you consider that the aquaculture sector in the region has recovered economically?

From a macroeconomic point of view, the sector has already recovered and production volumes have returned to pre-pandemic levels, both in the region and globally. At the level of small producers, there is a lack of information, it is necessary to carry out an analysis or a census and, based on this, to design the appropriate public policies.

4. If we had key information about these small players who are needing economic support, what kind of measures could contribute to improving their situation?

At FAO, we have classified fish farmers into two groups: the AREL (fish farmers with limited resources), with small production, many subsistence, highly vulnerable and are the target of government support programs. The other group, the AMYPE (small and medium-sized fish farmers), although they produce mostly for sale, still require support, especially during crisis. The levels and needs are different, the AREL micro-producers need an extensionist advisory force to accompany them, they need to strengthen their associativity, among other needs. By doing

things collectively, they have better opportunities to develop as producers and to be sustainable. AMYPE fish farmers already have open marketing channels, certain knowledge of technology, and management markets. Associativity is also very important. Working with collective brands of small producers that standardize their quality helps their introduction into the market and helps the consumer to identify the quality of the product, for this, policies are required, and sometimes NGOs can play an important role as a link between government and society. Many ingredients are commodities, with high inflationary pressures, in the face of this, small producers adopt substitution strategies, producing their own food with locally available ingredients, which is viable for species with a low trophic level species. Sometimes the enabling environment that governments are called upon to provide is not fully consolidated.

5. Regarding informal workers, how could governments improve their situation in the face of the next crisis?

First, to identify them, many of them are in the informal sector because they are geographically dispersed, the state does not reach where they are, and therefore, they do not participate in government programs, they are isolated, but they are still producers and have an impact on the economy of the community. A census is important, it is necessary to know how many there are, where they are and in what situation they are. This informality is sometimes due to geography, but also to ignorance, many believe that they will be charged or that they will have a fiscal impact. An intelligent communication campaign is needed to show them that it is in their own interest. Most fisheries and aquaculture authorities have few human and financial resources to reach these small, often informal producers. The involvement of leading farmers can be used to formalize and transfer knowledge to their peers through a self-management mechanism.

6. What was the impact of the measures to accelerate the digitization and innovation of the aquaculture sector taken in response to COVID-19 in the region?

There are trends to digitalize processes, one is the development of apps to consult in situations like this, which has happened before, while another is more related to reporting activities, which is important for statistics and measuring efficiency. I have not seen any difference as a result of the pandemic. The commercialization not only of aquaculture, but of products in general, through electronic sites has been a trend beyond the pandemic. Communication becomes faster in certain situations; in the case of natural disasters this measure is not as effective.

7. What would be the best actions to increase resilience and sustainability in the aquaculture sector, with a focus on small-scale producers?

It is important to have updated information, it is necessary to carry out analyses at the micro-regional level, the needs are different. I recommend making a diagnosis of the vulnerability of aquaculture to the effects of climate change as a basis for designing an economy-wide adaptation strategy. The vulnerability of the sector may vary from region to region. Information, on the one hand, and then the design of strategies, in the case of climate change, adaptation, and in the case of unforeseen external shocks, protocols that allow, as much as possible, to have an immediate response capacity to avoid this suspension of activities that has been so harmful to many producers.

8. Do you have any additional suggestions that could help to improve the economic recovery of the aquaculture sector?

To have information, but also to formulate action plans based on sectoral policies. Regardless of any shock, it is important that each economy has a strategy for the development of aquaculture to open markets, improve productivity and increase consumption. This must be formulated together with the actors of each region but implemented as an economy wide policy due to lack of resources or changing priorities, with a long-term vision. Consumption has increased in the region, but this must be part of an action plan that informs consumers and allows access to the vulnerable part of the population. Those who are aware that food from fisheries and aquaculture is healthy are people in the middle to high-income bracket, and they think of high-quality products such as salmon. The majority of the population does not have access to these resources. It is important that aquaculture contributes to food security by making products more accessible. It is important to include the small producer in institutional purchasing programs.

Annex 5.3: Virtual interview Chile representative

1. Which aquaculture production systems were most affected by the COVID-19 pandemic in Chile?

Salmon farming exports to more than 120 economies, many shipments go through the airport in Santiago, which are fast shipments of fresh salmon, others go through Argentina and by sea. The first affected route in salmon farming was the logistics of shipments for export due to quarantine restrictions. In Chile, quarantines were carried out by geographical area, and salmon farming is located in the three southernmost regions of Chile, there was a logistical problem related to exports. The government quickly listed the essential activities for the population, to which aquaculture producers were later added, by means of a safe pass that they had to apply for.

Another important production is mitilids, or mussels, unlike salmon farming, this occurs in a single region (Los Lagos) and there are also small producers that were in a more complicated situation. Many of them produce on the island of Chiloé, which is more isolated, where there are additional logistical problems. A third problem was the market restrictions, China was the first to restrict the export of salmon since they started to analyze the product. At customs they found a positive PCR, which meant that the processing plant (registered in Biobio) was restricted, at the beginning of the pandemic, we immediately conducted a remote inspection and with great effort and support from the Chinese ambassador and customs the plant was removed from the export restriction.

2. Do you think that aquaculture in Chile has recovered from this initial phase of the pandemic?

Yes, it has already recovered, the two types of aquacultures are already with positive numbers and they are already exporting to other markets, even expanding the range of markets.

3. Among measures for the aquaculture sector implemented by the government, which do you consider were the main ones that helped to mitigate the impacts?

In Chile, there is a very good relationship between the public and private sectors. Not only does the public sector take responsibility, but the private sector also looks for alternatives. This constant conversation we had with the associations allowed us to look for new ideas. Establish a permanent channel of communication with the union. In Chile, we are used to emergencies, we have an emergency committee, we activated the public-private emergency committee. The second is the government measures that could consider exceptions while maintaining sanitary control of the pandemic for aquaculture producers. It has not been as fast as we would like, especially for the mitilids, who are small producers. The third was to implement online channels, emergency phone numbers, emergency mail, and we also increased online procedures. We implemented procedures quickly, and electronic certificates increased.

4. Was there any financial support for small producers?

Salmon farming is very large and there has been no economic support for mussel farming. The companies themselves monitor the production areas and buy from small producers. We developed a support program with fishers to promote cooperation and entrepreneurship, especially among women. They received and applied technical training in order to diversify. For fishers, there was a project called "Caleta Inteligente", where Internet was installed in the landing areas for better management, we helped them with procedures to form cooperatives, supporting entrepreneurship more than anything, there were no subsidies.

5. What were the biggest challenges in implementing these containment and mitigation measures for the aquaculture sector?

The uncertainty of the markets because we did not know much about the pandemic. Internally, we also had problems with officials who were afraid to go to work for some inspections but we created a group of people who were available for that and created online procedures. There were inspections where we needed a minimum of staff and I thank the civil servants for that. The third thing would be the fight between aquaculture and agriculture, who has the most right to get these permits, there was a fight between two ministries.

6. Within the actions taken to accelerate the digitization and innovation of the sector, how important were these measures?

The digital part was the best part of the pandemic, it was the unexpected result, everything is already digital, inspections are even done remotely. There was a lot of interest from officials to

learn and train, even officials who were not from the technical areas, to be able to support. The online world allowed more and more meetings with the competent authorities in a very short time.

7. What strategies could be used to improve the situation of vulnerable groups, in the aquaculture sector to future crisis?

Productive diversification is essential, fishers must learn to switch to aquaculture, and this requires knowledge transfer, technology packages, and private support for small producers. It is a leap that has to be made. Then fishers should also jump into the world of adding value to resources, embarking on elements related to ship owners, gourmet products, and algae. Seaweed, for example, is a very important product today because of its nutritional value. There is a lot of money that economies have invested, but sometimes these projects fail due to lack of support and guidance from the government. In aquaculture, nobody talks about it, in Chile they didn't talk about it. Another option would be innovative aquaculture, aquaculture and tourism, for example, stations where people go to see how the fish are raised, for children to see. Women have developed companies where they take people diving, others have implemented a kit to make "asado", a kind of experiential tourism. Crafts with fish leather, everything related to summer camps for children. Basically, it is about diversifying both aquaculture and plant workers so that they have a plan B. We can no longer stop having plan B and plan C. Regarding recycling and circular economy, several economies have the concept of agro-aquaculture in their regulations, large producers also produce fish, for example native fish, which they use to feed the workers and even local people. Eating local products promotes food security. It is important that these places are small poles of food security through aquaculture and artisanal fishing.

8. Local fish products lose competitively at the price level, compared to foreign products. How can we encourage the population to pay a little more for them?

The seals, the certifications. In Brazil, for example, there is a seal for artisanal fishing. Consumers value environmental attributes and contribution to communities. Aquaculture has a bad reputation from an environmental point of view, aquaculture must be linked to consumption, limited production and circular economy. Economies like Peru have a high consumption of fish, but in the case of other economies where it is very low, it becomes difficult. Developing the accompaniment with non-traditional inputs for food changes the concept. Products made by women, produced locally. There are issues of consumer perception that need to be well understood to put a stamp on this aquaculture production.

9. What could be the best actions that should be implemented to increase resilience and sustainability in the sector?

Permanent communication between the public and private sectors, the private sector could take charge of the small producers. Maintain a permanent aquaculture-fishery governance, for climate change, pandemics, resource scarcity, etc. The second thing is to maintain support programs. Fishermen need to understand that resources are not forever. Maintain the associativity among fishers. Let the good examples be communicated to the rest, so that they can see among themselves how good entrepreneurship is. Regarding the training schools, for fishermen who participate themselves, as the message of the International Year of Artisanal Fisheries and Aquaculture 2022 says: "Nothing about us without us", to establish the exchange of knowledge between small-scale farmers from different regions and even economies.

Annex 5.4: Virtual interview Thailand representative

1. How hard was the aquaculture sector in Thailand impacted by the COVID-19 pandemic crisis and what is its current state?

It was affected from a moderate to high degree during the infection period. Aquaculture production and fisheries market was affected by the lockdown. During the COVID-19 most of the aquaculture markets were closed and people were prohibited from entering to risk areas. Fish farmers could not sell their products or sell them at low prices. During 2021 most of the aquaculture was recovered to near pre-pandemic levels, the fish farmers have produced more this year and the regulations were lifted.

2. Which were the main lessons of the COVID-19 pandemic for the aquaculture industry?

Pandemic can affect movement of people and food, throughout the entire value chain. The lockdown should be planned systematically so that non-infected people and non-contaminated

food can be transported to destined markets. Government should establish a certification system to ensure safe transportation of food to consumers. Governments should establish an emergency plan to manage the crisis. The implementation should be evaluated on a regular basis, so the emergency plan can be adjusted to minimize impacts. Aquaculture farms and fish markets should implement COVID-19 free practices to prevent contamination and infection. Fish farmers should also have response plans to adapt themselves to changes due to the COVID-19 situation, natural disasters and abrupt variations in the market.

3. Which were the main measures introduced by the government to mitigate the economic impact of the pandemic in the aquaculture sector?

In Thailand, the Department of Fisheries (DOF) under the Ministry of Agriculture and Cooperatives, introduced several measures. The first was COVID-free practices and certification to support transportation of farm products to processing plants and markets. Second, the DOF opened and facilitated market places within non-lockdown areas, promoting local consumption and demand. Third, the government established and implemented financial assistance programs, such as interest payment arrangements, set up e-commerce and online marketing of aquaculture products, opened new fish market channels, such as Fishermen Shops in the zero-COVID areas and low interest loans with the government support of 3% annual interest rate.

4. In your opinion, regarding these types of measures, which were the challenges that small scale aquaculture farmers encountered to access these programs?

There are several, I can point out three of them. First, the technology to online markets and access information. Second, fish farmers can sell their products to market channels provided by the DOF, but they will need to adapt their selling practices due to multiple harvests. Many small-scale farmers have debts and they can't find the access to loan contracts. Few farmers can access microcredits provided by the bank. Farmers should be encouraged to form cooperatives or groups for exchanging their knowledge, planning, and implementing activities to increase their business power.

5. How important were programs to accelerate digitalization and innovation applied in Thailand in Thailand to deal with this crisis?

The DOF established a pilot project to promote online markets, so that small-scale farmers can sell their product during the pandemic period. Later the DOF developed a more advanced platform for aquaculture markets by setting up an Aquaculture Innovation Centre (AIC) in every province. The AIC integrates academic institutions and governmental agencies of each province to start aquaculture innovation, including aquaculture practices, organizing meetings and seminars regularly at economy-wide and provincial levels communicating and transferring innovative technologies to fish farmers.

6. How could the government improve the situation of vulnerable groups to the effects of the pandemic or similar situations within the aquaculture sector?

This should be done by improving fundamental knowledge and research on the small-scale aquaculture and the management of relevant databases. In case of natural disasters, small-scale farmers can obtain some compensation provided by the government according to predetermined rules and procedures. The DOF has an important role to motivate and communicate with small-scale aquaculture farmers to be aware of natural disasters and climate change. There are local consultation meetings to develop emergency and response plans to mitigate the impacts such as preparation of stocks, culture ponds, use of chemicals, feeding and post-harvest. Inclusive groups are identified to be aided in the future but more work is required, and an aquaculture insurance policy is being prepared.

7. What could be the best responses to build sustainability and resilience in the aquaculture sector for future similar shocks?

This may be done through the implementation of partial financial support to SSA, building small groups of farmers, introducing new generation farmers, providing training and implementation of modern practices and biotechnology, innovative technologies in the farms, promoting online markets for sales and distribution.

8. Do you have any other suggestions to support the recovery and development of the aquaculture sector?

Government should have strong policy support to help aquaculture farmers to meet high quality standards. At present, SSA farmers have cooperated to form groups for exchanging their technical knowledge, but fewer efforts have been made to build business power. The pandemic has created higher costs, due to the disruption of markets and transportation. The DOF has yet to find ways to help them with this issue in the future, such as species diversification, improving relationships and the creation of associations and processing or cold storage facilities. Adaptive capacity on communication technologies would help with online meetings, direct sales to consumers, provide capacity building on preliminary fish processing, market knowledge, access to new markets, and online market and products development, added value products of interest for tourism, including ornamental fishes. Thanks to the shrimp board, the low-price mechanism and aid with cold storage facilities, the price of these commodities did not fall during the pandemic. Future development of SSA should put more emphasis on cooperation among producers. Having representatives of new generation farmers to cooperate and collaborate on planning and management would result in better understanding and knowledge gain, and the government can play an advisory role in support of required resources.

Annex 5.5: Virtual interview The Philippines and South Asia representative

1. What was the impact of the COVID-19 pandemic on the aquaculture sector in the Philippines and South Asia and has the sector fully recovered?

The COVID-19 pandemic disrupted transportation at all levels of the aquaculture supply chain. It has affected the transportation of seed stocks/fry/fingerlings from the hatchery to the nursery or grow-out facilities. It has affected the delivery of feed from feed mills to markets/distributors and/or farmers. It has affected the transportation of harvested products from farms to markets, fish ports or restaurants. Some restaurants were closed during the pandemic, so aquaculture products that were normally delivered to these restaurants were stuck somewhere. In places without storage or post-harvest facilities, they were sold at break-even or even low prices rather than left to rot. Staff deaths and severe cases of COVID were inevitable at the height of the pandemic. In addition, some facilities reduced staff to minimize costs, while others closed. These staff reductions affected production and other activities along the supply chain. Today, the sector has recovered, but not fully. Recovery will depend on the losses incurred during the pandemic and the availability of capital to finance a fresh start.

2. Compared to other aquaculture production, how did the aquaculture of mollusks perform during the COVID-19 pandemic?

Mollusk culture was not much affected during the pandemic, especially the two most important mollusk species produced in the Philippines: oysters and mussels. These are non-fed species and the seed stocks are from the wild. Culture begins with the settlement of competent larvae on available clutches and continues until they reached harvestable size. The need for farmers' hands-on involvement is only during clutching, harvesting and marketing. Although marketing has been affected due to lack of transportation, the farmers can leave them untouched in the culture areas until the condition becomes favorable and the situation is normal. Prolonging the crop doesn't involve any additional cost because no feed is needed, and it provides a source of food for the farmer, his family and his community.

3. Compared to traditional monocultures, how did IMTA systems performed during the COVID-19 pandemic?

IMTA is an emerging technology in the Philippines. It is not a major aquaculture system. Where IMTA is practiced, it is usually at the experimental level, not large-scale and commercial. I am not able to answer this question given my limited knowledge of where and what IMTA activities, if any, are ongoing.

4. What was the role of the SEAFDEC and research institutions in the aquaculture sector during the COVID-19 crisis?

SEAFDEC was affected by the pandemic, but not to a detrimental extent. Field experiments in areas accessible only by public transportation were either suspended or intermittently monitored. However, experiments, studies and hatchery production within our stations (Tigbauan Main Station, Igang Marine Station, Dumangas Brackishwater Station and Binangonan Freshwater Stations) were not affected. The support allowed us to continue our activities regularly with minimal disruption, which in turn allowed SEAFDEC to continue providing technical assistance

and seed stock to farmers within its reach. At the height of the pandemic, SEAFDEC continued to build its broodstock and hatchery facilities, which were open and operational in time after the pandemic. This pandemic, which brought most industries to a standstill, not only aquaculture, has taught us the importance of protecting manpower resources, the driving force of the industry. It has also taught us to prepare for the future, not only for the worst-case scenario, but to be ready with improved facilities to fast-track the activities missed during the lockdown and to compensate for the losses when the situation returns to normal.

5. What could be the best responses to accelerate transformations in the aquaculture sector to enhance its sustainability and resilience?

This experience has taught us lessons that can make us well-prepared for similar future events. We saw farmers needing assistance in getting their products from farm to market. We saw farmers selling their produce at very low prices to make the most of their harvest. In the future, with the capacities of the local government units they can assist the farmers by buying their products and distributing them to quarantine facilities or households during the lockdown. They can assist farmers by helping them find markets. The government should also build infrastructure such as cold storage and processing facilities in the major fish and aquaculture-producing provinces or cities to preserve the products and extend their shelf life. These facilities are only available in metropolitan areas such as Manila, Cebu or Davao. Multi-species hatcheries and feed mills should also be strategically located and easily accessible to farmers to ensure steady production and supply of seafood. The government should design and implement programs to increase food sufficiency in the small islands to minimize the dependence on supplies from more urbanized cities.

6. What considerations should governments have when promoting the development of more sustainable aquaculture?

Polyculture and aquasilviculture may have been practiced for quite some time, but IMTA is just emerging. For a government-assisted project to succeed, somebody has to oversee it from conceptualization until harvest. The government should consider providing technical assistance to the farmers interested in these production systems, especially when new concepts are being introduced. The government should provide funds to the farmers for them to attend training courses to better understand these new systems. Financial assistance, such as loans with farmer-friendly terms to help them start their businesses. For the beginners, the government can assist in finding and establishing markets for their products.

7. How can aquaculture enterprises benefit from the adoption of more sustainable practices?

Some farmers, especially those with limited financial resources, are hesitant to invest in something without the assurance of a large profit. Government agencies or research institutions must first invest in educating them about these sustainable practices and how profitable they can be to convince them. They should realize that adopting sustainable aquaculture practices does not only bring financial returns but is also beneficial to the environment. Aquaculture practices that are damaging to the environment would deprive the next generation of clean waters for their fishing, aquaculture, and recreational activities. Adopting sustainable practices also ensures food security and a healthier ecosystem.

8. Do you have any additional suggestions that could help in the development of the small-scale aquaculture sector?

In poor economies, such as the Philippines, we can't solely depend on the government to provide for all the needs of the small-scale aquaculture sector. Tie-ups or collaborations between government agencies, the private sector, research institutions, or the academy may be more efficient and beneficial to all concerned parties. The research institution or the academy can provide science-based technologies developed through research, the private sector can provide the capital, and the government agency can oversee and monitor the project. These joint endeavours may speed up the development and help boost production from the small-scale aquaculture sector.

Annex 5.6: Virtual interview New Zealand representative

1. In your opinion, why the aquaculture in New Zealand was not as hardly impacted by the COVID-19 pandemic crisis compared to other economies?

Salmon was most affected, as its main market was the restaurant trade, but like shellfish it could also be sold to the domestic market, although not at such a high premium. All species were also able to be left in the water for a period without being forced to harvest, allowing some delays in supply. The industry also has a resilience that has allowed it to survive. Although they compete, they tend to come together in mutual support when under duress. The strengths of New Zealand's primary industry also help with the situation.

2. What is the current situation of the aquaculture in New Zealand compared to pre pandemic levels?

Marketing is picking up and people (internationally) are now visiting restaurants again, which is helping the industry. Production will be down a little, partly due to Covid-19 impacts, delayed knock-on effects, but also due to climate change, existing salmon farms are getting warmer with little opportunity to move to cooler waters due to other stakeholder conflicts. Mussel spat supply is at a premium, for a variety of reasons, which will have a delayed impact.

3. In your opinion, currently is there a need to develop actions/programs for the economic reactivation of small-scale aquaculture in your economy?

I believe the aquaculture industry will generate strategies within themselves and then work with the Government to obtain suitable support. This may be in terms of facilitating work visas, which is still an issue, through encouraging markets.

4. How important were actions to accelerate digitalization and/or innovation in New Zealand to deal with the COVID-19 crisis?

It is important although some do not realize the potential benefits. Data utilization/manipulation and innovation will provide an edge that is required going forward to armour against future stress events.

5. How could governments improve the situation of vulnerable groups to the effects of the pandemic or similar stressors within the aquaculture sector?

Enabling sustainable accessibility and the means to develop into existing aquaculture enterprises or supporting innovation to advance such developments will enable smaller/vulnerable/subsistence activities to advance. The development and incorporation of restoration activities and "marine produce gardens" will also enlighten and enhance the ecology and subsistence production.

6. What could be the best responses to accelerate transformations in the aquaculture sector, particularly small-scale aquaculture, to build sustainability and resilience?

Most of the major species, king salmon, oysters, mussels, are investment intensive. Smaller players need to develop alternative species that require less initial investment, or the development of co-operatives with a central supply/market hub with satellite growing facilities. This is not a traditional avenue of development for New Zealand and may struggle to gain traction. New species and innovation are the key to advancing development. Spinoff industry (e.g., from the blooming seaweed sector) will lead to developments and allow smaller players into aquaculture related activity.

Annex 5.7: Virtual interview Indonesia representative

All expressed views in this document represent the personal views of the contributor based on his experience in the aquaculture subsector and the reviewed literature.

1. How hard did COVID-19 impact the aquaculture sector in Indonesia and has the sector completely recovered to pre pandemic levels?

Covid-19 has significantly affected the aquaculture subsector in Indonesia. The 2021 annual report published by the Indonesian Ministry of Marine Affairs and Fisheries (MMAF) summarized that the growth of aquaculture production between 2020–2021 was -13.57% for fish, 0.05% for seaweed with a total contraction for all aquaculture products of -5.33% compared to the previous year pre pandemic level. The tentative production figures for the third semester of 2022 show

that aquaculture production has reached 90% of the 2022 target. This means that all the target productions of 2022 will likely be achieved, which are higher than the total production of 2021.

2. What were the main government measures that contributed to mitigate the outcomes of the COVID-19 pandemic on the aquaculture sector in Indonesia?

There were significant changes in the aquaculture development in Indonesia during the COVID-19 pandemic, driven by the recent change of aquaculture policy pursued by the new minister of MMAF, which seeks to increase the welfare index of fish farmers, production efficiency and guarantee the supply chain to improve the price of primary commodities. Some of the programs include improving the supply of seed, broodstock, locally produced fish feed, and increasing the application of biofloc farming system, fish farming in rice paddy (minapadi), improving the farming technology by introducing better farming systems, biosecurity, waste management and farming area management. All these programs are bundled within the new three strategic pillars of aquaculture development in Indonesia, which are prioritize first the ecological sustainability of aquaculture development, followed by increasing economic benefits of the sub-sector through the development of highly competitive commodities based on export and market demands and improving the socio-economic condition of fish farmers.

A direct intervention by MMAF to improve the condition of aquaculture activities was the enactment of a Decree of the Directorate General Aquaculture (DGA) of MMAF regarding the COVID-19 Protocol Enforcement on Aquaculture Business Activities. Decree #B.21940/DJPB/VIII/2021 regulates several critical points in aquaculture systems which is intended to provide a guarantee when the products are exported to other areas or overseas.

3. What were the major challenges that small-scale aquaculture (SSA) farmers experienced in your economy to access government support/programs?

The main challenges are:

A. Most of the fish farmers in Indonesia are small-scale and distributed across Indonesia, and many reside in some of the most remote areas with limited information access and available communication infrastructure. Patronage flourish in these communities where fish farmers rely on intermediaries and local businessmen for support in farming and daily needs. This patronage system becomes another major challenge to access government programs.

B. Small-scale fish farmers are required to form a formal cooperative or group to receive a direct endowment program. However, existing fish farmer cooperatives are few and far between. Thus, the government usually forms instant cooperatives or groups to distribute direct support legally. Therefore, the effect of direct support is minimal in improving farming practices and production due to the fish farmers within the instant cooperative not working together.

C. Most small-scale fish farmers have a low educational background and believe that the credit scheme is a burden although it will help them improve their fish farming activities. Education also plays a vital role in behavioural change, for example, scepticism to accepting new fish farming technologies, improving farming practices or learning new things in fish farming.

D. Some direct supports are too advanced for small-scale fish farmers and challenging to implement in the existing farming conditions.

4. How important were programs to accelerate digitalization and/or innovation in Indonesia to deal with the COVID-19 crisis and the post-pandemic scenario?

Digitalization of aquaculture in farming activities is scarce and most experiences are still in the research stages. Some startup companies, such as e-fishery, have developed robust water quality monitoring systems, automatic feeding and several other innovations in aquaculture. However, the cost of running the system, including licensing, is just too expensive for small-scale fish farmers. I led a research program in cooperation with Japan called SATREPS Mariculture to try to introduce digitalization and innovation in fish farming. We developed several digitalization systems such as real-time water quality monitoring system, digitalization of operational records, display viewer for water quality and educational and training platform. Despite the system working perfectly and being free of charge, fish farmers have very little interest in using it due to their strong attachment to their local and personal knowledge-based experience.

Several market systems and traceability were developed by the MMAF as part of the effort to digitalize the market system and improve traceability. An application called STELINA was launched by MMAF to serve just that purpose. However, the rate of use and voluntary reports

were relatively minimal, and thus, the ministry still relies on manual data records. Digitalization and innovation are the future of aquaculture, where production efficiency and improved profits can be achieved. However, the awareness of fish farmers, especially small-scale fish farmers, must be increased to ensure high acceptance and use of digital fish farming. Digitalization of farming practices also helps during a pandemic similar to COVID-19. It simplifies business activities and efficiently uses resources.

5. How could governments improve the situation of vulnerable groups to the effects of the pandemic or similar stressors within the aquaculture sector?

Improving educational levels and competencies of members of vulnerable groups to be able to adapt to changing conditions or stressors. Providing education facilities near vulnerable groups for easier access. Identifying the vulnerability risks within these groups and providing both direct and indirect support to eradicate them. Increasing awareness among small-scale fish farmers of inherent vulnerability risks within their aquaculture systems and the environment through online educational platforms, media and other sources of information. The government, in tandem with related organizations, should also be able to provide guidance or increase the knowledge of small-scale fish farmers and other vulnerable groups in quickly identifying indicators of vulnerability risks and facilitating discussion on how to overcome them. Identifying poorly performed capital assets and improving them through specific endowment programs to allow vulnerable groups to compete with their peers with better capacities.

6. What could be the best responses to accelerate transformations in the aquaculture sector, particularly small-scale aquaculture, to build sustainability and resilience?

It is difficult to single out the best responses to accelerate the transformation in the aquaculture sector since the different farming systems in different areas of Indonesia face different problems and challenges. However, feed has been one of the major challenges faced by small-scale fish farmers due to the price and consistent supply, particularly during the COVID-19 pandemic, where depleted stocks of fish feed in some areas took time to be replenished with increased price. Transforming economy-wide and local fish feed mills using locally sourced ingredients, especially fish meals or its comparable replacements, could provide a consistent supply of feed at a reasonable price. Lastly, small-scale fish farmers sit at the bottom of a long aquaculture chain. To improve the sustainability and resilience of these operations, shortening the market chain and empowering them through partnerships such as community-supported fisheries model might reduce their vulnerability concerning human, physical, social and financial capital assets.

Annex 5.8: Virtual interview Peru representative

1. How severe was the impact of the COVID-19 crisis on aquaculture production systems in Peru and what is the current state of the sector?

Many of the transit restriction measures affected the supply chain causing difficulties for the transport of products to markets and inputs for production, such as seeds and feed, which reduced the income and caused lack of liquidity. Production costs increased due to the shortage of inputs, the closure of restaurants and consumption centers, the reduction in prices of aquaculture products, among others. In addition, an increase in robberies was reported within aquaculture fish farms due to reduced security, as well as smuggling of aquaculture products due to the reduction of controls, suspension of inspection and the reduction of institutional attention to producers. For the year 2019 the annual aquaculture production was 161,279MT and for the year 2020 of 150,816MT, comparing those years the production was 6.4% or 10,463 MT less. Currently, with respect to 2020 a slight increase in aquaculture production is seen, with the production of 2021 being 150,816MT, however, it hasn't recovered to 2019 levels.

2. What were the main measures implemented by the government of Peru that helped mitigate the effects of the COVID-19 pandemic in the aquaculture sector?

The Peruvian Government implemented the "Reactiva Peru" program, which aimed to provide a rapid and effective response to the liquidity needs faced by companies, this program included AMYPE fish farmers. Given the limitations on the transport and sales of aquaculture products, the program "A Comer Pescado" strengthened their actions through the participation of aquaculture producers in itinerant markets/promotion fairs (Mi Pescadería, temporary local markets, satellite markets, others), for direct sales to the consumer thus avoiding intermediaries. Moreover, sale

platforms for aquaculture products articulated with regional and local governments were promoted, as well as the articulation of aquaculture producers with commercial channels.

3. What experiences were obtained with the special credit programs for AMYPE and AREL aquaculture farmers?

The Ministry of Production through FONDEPES approved the EMERGENCY CREDIT PROGRAM (COVID-19) through Chief Resolution No. 028-2020 -FONDEPES/J and its amendments. This program was framed within the Institutional objectives of FONDEPES to facilitate access to financing opportunities under exceptionally promotional credit conditions that contributed to the recovery and reactivation of aquaculture activities (AREL and AMYPE), as well as artisanal fishing activities with more flexible credit conditions. The emergency credit also implemented a 100% virtual service platform (www.fondepes.gob.pe) for financing working capital, exceptionally, awarding credits in cash. For the year 2020, 501 credits were awarded, benefiting 365 AREL farmers and 136 AMYPE farmers, for an amount of PEN1,002,000.00 for working capital.

4. What were the biggest challenges faced by the government in implementing post-COVID-19 mitigation and economic recovery measures for the aquaculture sector?

Some challenges were noted such as non-compliance with the requirements demanded by the general financing programs (FAE-MYPE and REACTIVA Peru) such as active RUC, ticket issuance and budget limitations. Additionally, the informality of aquaculture farmers, due to lack of formal resolution for the development of the activity, sales record, commercial transaction documents such as receipts, invoices, inactive RUC or limited credit record information in financial institutions. Furthermore, limitations in access to information provided virtually and physically on actions of technical assistance, training, as well as financing programs; since in many parts of the territory there are deficiencies in coverage and connectivity, internet service, computers, telephone lines, etc.

5. What actions are being implemented by the Peruvian government to accelerate the digitalization of the aquaculture sector after the COVID-19 crisis?

Regarding digitalization, the Ministry of Production, through FONDEPES, implemented the CREDIPES app to make it easier for fish-farmers to access the different credits, which can be downloaded to any cell phone and from there carry out the respective procedures. Allowing all those interested in accessing credits from any part of the territory, which includes balanced feed for the fattening stage, acquisition of materials and equipment, expansion of infrastructure, hatchery, purchase of eggs and/or fingerlings, among others. Likewise, the RAPIPEZ application is being implemented, which is a digital portal that allows the acquisition of hydrobiological resources from anywhere in the economy from a computer or mobile phone. Moreover, the Program for Innovation in Fisheries and Aquaculture (PNIPA) implemented the SAPEL application, a system through which the processes of tendering, calling, selection, negotiation and awarding of innovation fishing and aquaculture subprojects are managed, as well as their execution, monitoring and closure.

6. What strategies could be used to improve the situation of vulnerable groups in the aquaculture sector to the effects of stressors like the COVID-19 pandemic?

Promote the formalization with the support of specialized professionals who provide and guide the assembly of the formalization files and follow-up of the procedure. Create a catastrophe aquaculture insurance whose coverage allows farmers to continue with their activities in the face of affectations generated by natural events. Strengthening capacities of aquaculture producers that allow them to acquire knowledge on measures to be adopted in the face of natural disasters and climate change. Strengthening capacities on safety and health at work that increase the profitability, since savings can be generated thanks to the prevention of diseases and attendance at workdays of workers, reducing turnover and absenteeism.

7. What measures could enhance the full economic recovery of the aquaculture sector in Peru?

Promote seed production in economy-wide production centers, as well as strengthen the capacities of aquaculture producers to produce seed for self-supply and/or sale. Increase funds, as well as sources of financing and innovation. Increase R+D+I capacity in aquaculture, promoting productive development and competitiveness through research, technology adaptation and

capacity building in the aquaculture sector. Promote the production of balanced feed that includes inputs from the region to reduce costs. Promote the participation of aquaculture producers in traveling markets, promotional fairs, temporary local markets, satellite markets, business roundtables, among others. Create an aquaculture extension program based on promoting the development of aquaculture activity through training, technical assistance and permanent on-site monitoring in the farming process to improve and increase aquaculture production, which in turn contributes with productive scaling, formalization, business management, commercial articulation, associativity and innovation. Generate synergies with economy and international sectoral entities linked to the sector that contribute to the responsible and sustainable productive improvement of aquaculture.

Annex 5.9: Virtual interview Singapore representative

1. From your perspective, how hard did the COVID-19 crisis impact the aquaculture sector in Singapore and what is the current state of the sector after this shock?

Singapore is not an aquaculture or agriculture economy and would rely mostly on imported food sources which make up about 90% of total food consumption. Although the local aquaculture sector is small with 110 coastal farms and less than 20 land-based farms, the impact of COVID-19 on the aquaculture industry was felt but not significant. The local aquaculture production in 2020 during Covid-19 crisis fell to about 3,960 tons which was reported to be the lowest since 2014. According to the Singapore Food Agency, the pandemic had led to disruptions in the setting up of new farms and the upgrading of some existing farms which could result in consequential impact on farm timelines for reaching production capacity. Following the pandemic crisis, the aquaculture industry took in great stride the demand set upon them by the government to ramp up production to meet the 30x30 goal for enhancing food supply resilience and food security. A few major aquaculture producers had started investing in smart technology to help increase production capacity and yield.

2. What were the main measures applied by the government to mitigate the effects of the COVID-19 pandemic on the aquaculture sector in Singapore?

Apart from the COVID-19 pandemic, there are other concerns such as global resource constraints, effects of climate change and the growing global population that could impact on food supply resilience in Singapore. Singapore has set eyes on leveraging agri-food technologies to develop and commercialize solutions for sustainable food production. The Singapore Food Agency had announced plans to ramp up local production to increase nutritional sufficiency from 10% to 30% by 2030. It aims to achieve this in land-scarce Singapore by harnessing technology, increasing space for farming, as well as supporting local agriculture and aquaculture other than encouraging consumers to buy local produce.

The Lim Chu Kang (LCK) Masterplan, under the Singapore Food Agency's masterplan for enhancing food security, 390-hectare land situated in the LCK agricultural zone would be redeveloped sometime in 2024 into a high tech agri-food cluster with capacity to produce thrice the current food production. More sea space in the Southern Waters and East Johor Straits will be tendered out progressively in phases starting from end 2022 with longer lease according to the Singapore Food Agency.

Enterprise Singapore set aside SGD55 million for helping local agriculture and aquaculture companies to develop new capabilities and innovate focusing on the concept of growing more with less. Through the Startup SG Accelerator program set up by ESG, the agency brought in global accelerators such as Big Idea Ventures, GROW, Hatch Blue, The Yield Lab, Trendlines, Agrifood Innovation Centre and Temasek Life Sciences Accelerator to groom more than 150 agri-food tech startups over a three-year period. The startups would be able to learn about fund-raising, product development, commercialization and internationalization through the mentorship by the accelerators.

3. Were programs to accelerate digitalization and/or innovation in the aquaculture sector applied or boosted in Singapore after the COVID-19 crisis?

In April 2021, SFA launched the Agri-food Cluster Transformation (ACT) fund of SGD60 million for 5 years. Replacing the former Agriculture Productivity Fund, the ACT provides co-funding support for farms and companies in technology upscaling, innovation and test-bedding and

capability upgrading to achieve the “30x30” goal by 2030. SFA is providing R&D funds for local institutes of higher learning and research institutes. The SFS grant is administered under 3 broad categories in the areas of diversification of import sources, growing food locally and growing food overseas.

4. Considering the limitations of the small-scale aquaculture sector, in your opinion, what strategies could be used by governments to achieve proper transfer of new technologies to the small-scale aquaculture sector?

The current local aquaculture industry is fragmented and reliant on traditional farming practices and operations for most of the coastal farms. Establishing centralized infrastructure and support systems for water treatment, waste management, feed supplies & warehousing, hatchery, food processing and cold chain management would benefit the small-scale aquaculture producers. Strategies such as reducing the capital investment and operation costs, or supporting infrastructure and equipment are key.

5. How could governments help to improve the situation of vulnerable groups within the aquaculture sector?

Provide training subsidies for farms so their employees can enhance their knowledge and skill competency in farming. They would be able to have the versatility and confidence to take on more tasks or responsibilities for upward career mobility in the industry. Create career development and progression pathways in the industry. Provide mentorship services and funding support to help small scale or subsistence producers in improving their farm productivity.

6. What could be the best responses to accelerate transformations in the aquaculture sector, particularly small-scale aquaculture, to build sustainability and resilience?

Availability of a properly funded and competence extension service organization to provide technical support and mentorship to farms in applying technology and good aquaculture practices for responsible and sustainable farming. Having a knowledge-based farming approach would help farmers understand the basics of farm care and husbandry, good and responsible practices for better management of farm operations and production through training and education. Build a farming network for farms to share their farming success, issues and resources. A support scheme for addressing common issues across farms. Encourage start-ups with support and guidance from accelerator program and funding schemes as well as financial investment in addition to mentorship in their farming journey. Allocation of suitable sites with ready infrastructure for supporting super intensive farming, post-harvest technology and processing with efficient cold chain management. Provide locally produced fry and feeds customized for local warm water species

Annex 6. Workshop summary

The “International Workshop on Capacity Building to Improve Economic Reactivation, Resilience and Sustainability of Aquaculture Within the Context of Recovery of the COVID-19 Pandemic” was held virtually in two sessions (I and II) in two consecutive days on 16-17 March 2023 (UMT-5, Lima, Peru time zone) and organized by the General Direction of Aquaculture from the Ministry of Production of Peru and the consulting company Equilibrium SDC, based in Lima Peru, for the OFWG of APEC. The full workshop agenda can be seen in Annex 7.

The objective was to build the capacity of government officials responsible for policies in the aquaculture sector of APEC economies, through a two-day virtual workshop, to better understand the challenges and benefits of economic recovery initiatives for aquaculture, with an additional approach to enhance digitalization, sustainability and resilience. The workshop focused on small-scale aquaculture, including recommendations to improve the design and implementation of such initiatives in APEC economies, within the context of recovery from the pandemic.

The first session had 58 participants from eight APEC economies, including Peru with 40 participants, Indonesia (5), Thailand (4), Mexico (3), Malaysia (2), Chile (2), China (1) and Japan (1). The second session had 41 participants from four APEC economies, including Peru with 32 participants, Chile (3), Thailand (1) and Indonesia (1), with two speakers from Uruguay, one speaker from Italy and one speaker from the Netherlands. In both sessions of the workshop there were a total of nine international speakers from a diverse group of economies such as Chile; Japan; Malaysia; Netherlands; Peru; Thailand; Uruguay, and Italy/China. The speakers included representatives from intergovernmental organizations (INFOFISH, INFOPECSA and FAO), universities and research institutions (Japan International Research Center for Agricultural Sciences and San Marcos National University, Lima, Peru), non-profit organizations (Aquaculture Stewardship Council, Netherlands), as well as government officials from APEC economies (Department of Fisheries, DOF, Thailand and Undersecretary of Fisheries and Aquaculture, SUBPECSA, Chile). One of the objectives of the workshop was to obtain at least 30% female participants, which was accomplished, since the final composition of attendees was 60% female and 40% male. Moreover, there were four male speakers (44%) and five female speakers (56%).

RECOMMENDATIONS DEVELOPED DURING THE WORKSHOP

Summarizing all presentations in both sessions, a list of policy recommendations was framed. Such recommendations include:

1. Governments must increase the collection of high-quality socioeconomic data related to small-scale aquaculture in their economies, including sex-disaggregated data. This is key to analyze the benefits of the reactivation policies in place and to adequate such policies when needed. Recommendation came from the discussion of the researcher report and the presentation of Ms. Froukje Kruijssen.
2. There is a need to strength the governance of the aquaculture sector by developing emergency protocols for unforeseen external shocks. Recommendation came from representatives from Peru.
3. APEC economies must embrace the global new customers' trends from the pandemic related to digital services, local consumptions and open markets, and the demand for processed products and help in promoting seafood products accordingly. Recommendation came from representatives from Malaysia.
4. A key measure in the development of aquaculture in economies where the small-scale sector dominates the industry is to build an economy-wide strategy to enhance the association of small-scale farmers. Recommendation came from representatives from Peru.
5. The pandemic served as a new momentum for the digital transformation of aquaculture in terms of e-governance, marketing and advanced monitoring technologies which should be discussed by government officials to explore actions that can still be taken in this regard. Recommendation came from representatives from Chile.
6. Promoting diversification of products and processes will be key for the future of aquaculture, however the sustainability aspect of such actions must always be considered for the blue transformation of aquaculture. Recommendation came from representatives from Thailand and from the presentation of Mr. Xinhua Yuan.

Annex 7: Workshop agenda

Duration	Activity
Day 1: Thursday, 16 March 2023	
SESSION I – CURRENT POST-PANDEMIC SCENARIO AND EXPERIENCES WITH DIGITALIZATION IN THE AQUACULTURE SECTOR	
24h format, Time-zone (UMT-5, Lima-Peru)	
19:00-19:05	Introduction by moderator
19:05-19:10	Opening remarks by the General Director of Aquaculture from the Ministry of Production of Peru
19:10-19:40	Presentation of the Research Report <i>Speaker:</i> Mr. Victor Alexander Cueva Quiroz, Leader of the consulting team for Equilibrium SDC
19:40-19:50	Opinion of participants and discussion of the proposed recommendations
19:50-20:05	Recent advances in Asia Pacific aquaculture markets <i>Speaker:</i> Ms. Shirlene Maria Anthonysamy, INFOFISH Director
20:05-20:10	Q&A from participants
20:10-20:25	Thai government support for the economic recovery of aquaculture after the COVID-19 crisis <i>Speaker:</i> Ms. Jitlada Sritrakul, Fisheries Development Policy and Planning, Department of Fisheries, Thailand
20:25-20:30	Q&A from participants
20:30-20:45	Do online communities of practice complement or substitute conventional aquaculture extension services? <i>Speaker:</i> PhD. Guenwoo Lee, Researcher Social Science Division Japan International Research Center for Agricultural Sciences (JIRCAS)
20:45-20:50	Q&A from participants
20:50-21:05	Discussion of recommendations for economic reactivation of aquaculture: Opinion of participants and speakers (guided by moderator)
21:05-21:10	Application of event survey and closing remarks by moderator
Day 2: Friday, 17 March 2023	
SESSION II – ECONOMIC RECOVERY AND EMERGING FROM COVID-19 WITH A MORE SUSTAINABLE AND RESILIENT AQUACULTURE	
24h format, Time-zone (UMT-5, Lima-Peru)	
8:00-8:30	Association of small producers in the agricultural sector <i>Speaker:</i> PhD. Jhon Valdiglesias Oviedo, Principal Professor of Economics at San Marcos National University, Lima, Peru
8:30-9:00	Policies for aquaculture growth and long-term sustainability <i>Speaker:</i> Ms. Froukje Kruijssen, Aquaculture Stewardship Council, Netherlands
9:00-9:15	Impact of COVID-19 on trade in fishery and aquaculture products <i>Speaker:</i> Ms. Graciela Pereira, Executive Director INFOPECA
9:15-9:20	Q&A from participants

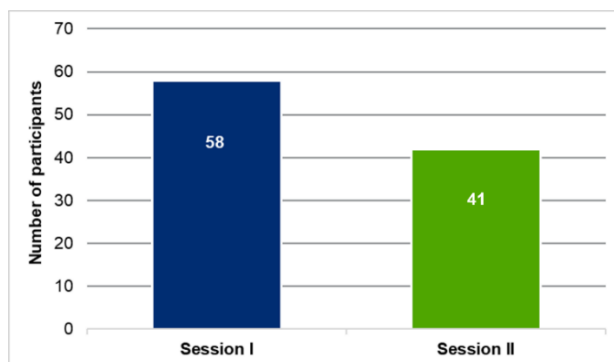
9:20-9:35	Chilean response for the economic reactivation of aquaculture in the post-pandemic scenario <i>Speaker:</i> Ms. Marisol Álvarez, Head of the Management and Policies Unit, Aquaculture Division, Undersecretary of Fisheries and Aquaculture (SUBPESCA)
9:35-9:40	Q&A from participants
9:40-9:55	Blue Transformation and aquaculture resilience: lessons learned under COVID-19 <i>Speaker:</i> PhD. Xinhua Yuan, Deputy Director of the Fisheries and Aquaculture Division, FAO
9:55-10:00	Q&A from participants
10:00-10:15	Discussion of recommendations for economic reactivation of aquaculture: Opinion of participants and speakers (guided by moderator)
10:15-10:20	Application of event survey and closing remarks by moderator
10:20-10:40	Closing remarks by the General Director of Aquaculture from the Ministry of Production of Peru

Annex 8: Indicators of the workshop

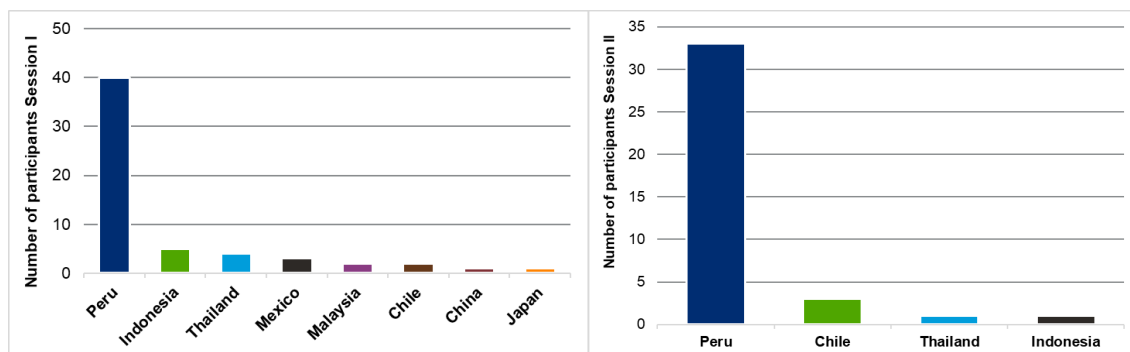
Data from the surveys applied at the end of each Session of the event were used to evaluate the performance of the workshop with different indicators.

Number of participants and APEC economies representatives present in the workshop

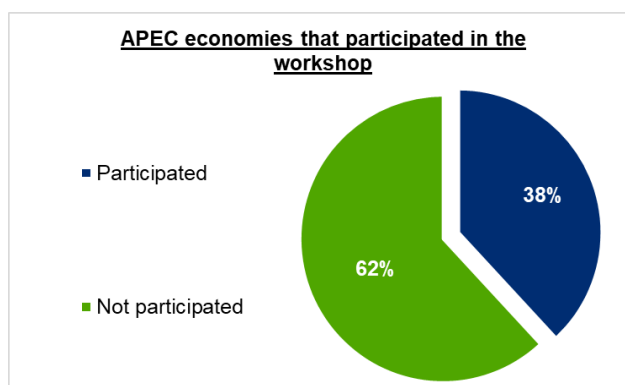
The first session not only had the maximum number of participants (58) but also the greater number of representatives from different APEC economies with eight (Chile; China; Indonesia; Japan; Malaysia; Mexico; Peru and Thailand), while the second session had representatives from four APEC economies (Chile; Indonesia; Peru and Thailand).



During the first session Peru had 40 participants, Indonesia (5), Thailand (4), Mexico (3), Malaysia (2), Chile (2), China (1) and Japan (1). During the second session Peru had 32 participants, Chile (3), Thailand (1) and Indonesia (1), there were additional participants (speakers) from Uruguay, Italy and the Netherlands.

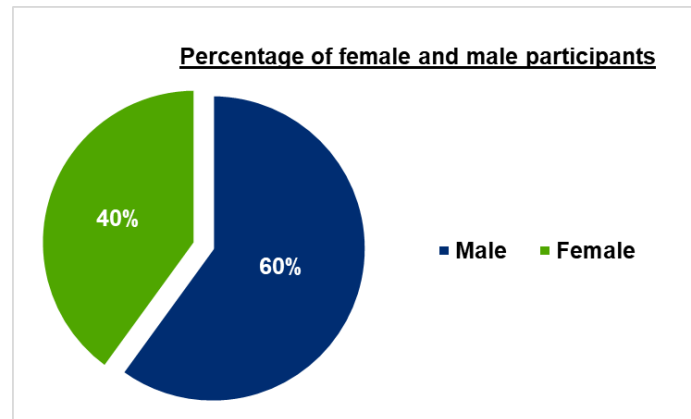


Eight APEC economies (8/21, 38%) had at least one participant during either of the two sessions, which were: Chile; China; Indonesia; Japan; Malaysia; Mexico; Peru and Thailand.



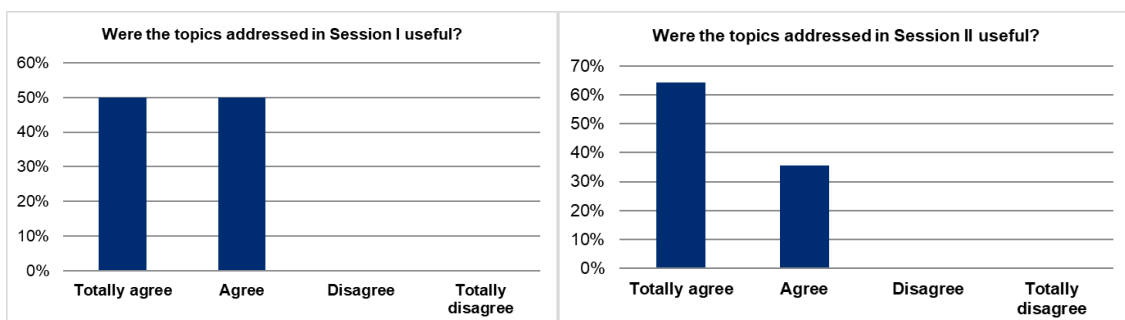
Indicators of gender

Overall, on both sessions, the percentage of male participants was 60%, while 40% of the audience was female. Regarding the speakers, there were four male speakers (44%) and five female speakers (56%), both results were in line with one of the main goals of the project: to accomplish at least 30% female participation. In both sessions there were a total of nine international speakers from a diverse group of economies such as Chile; Italy/China; Japan; Malaysia; Netherlands; Peru; Thailand and Uruguay.



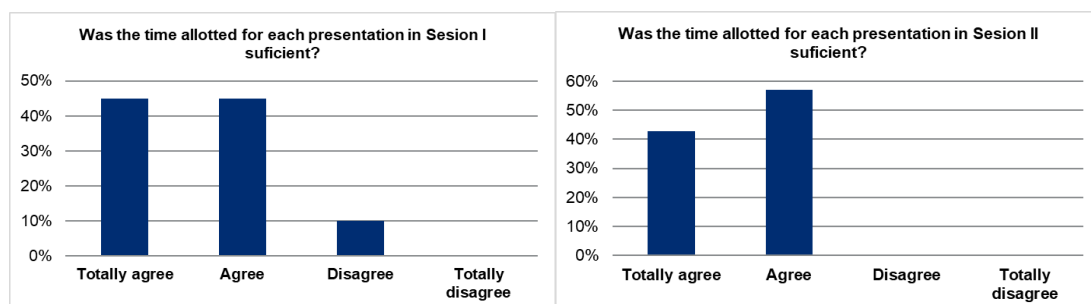
Indicators of relevance of the information

When participants were consulted about the usefulness of the topics addressed in Session I, all participants responded positively (50% totally agree and 50% agree). Similar feedback was obtained from Session II with 64% respondents that answered totally agree and 32% that agree.



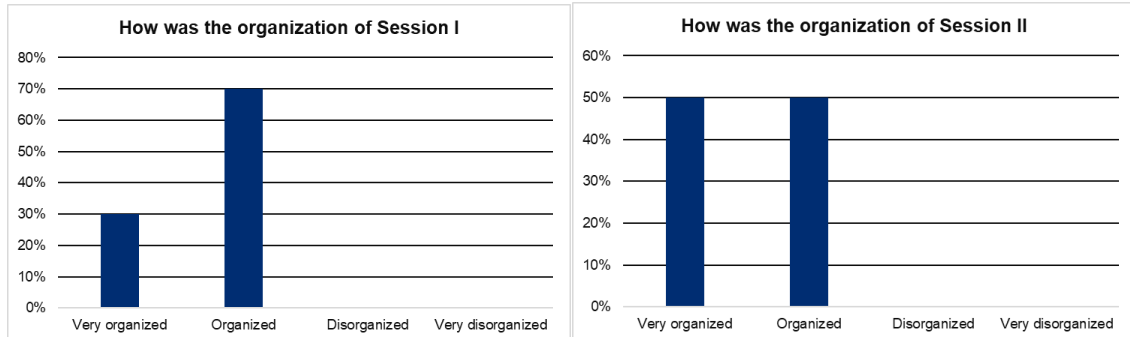
Fitness of time allotted for each presentation

Attendees were consulted about the time allotted for each presentation, regarding if it was sufficient to cover each discussion properly. For Session I, 90% responded positively (45% totally agree and 45% agree) while only 10% disagree with this remark. For Session II, 43% totally agree, 57% agree and there were no negative responses.



Organization of the workshop

For Session I, the general appreciation of the organization of the workshop was that 30% of the participants surveyed considered that it was very organized and 70% organized, while for Session II 50% responded that it was very organized and 50% organized. No participants declared that it was either disorganized or very disorganized for neither of the sessions.



Annex 9: Photographic glossary

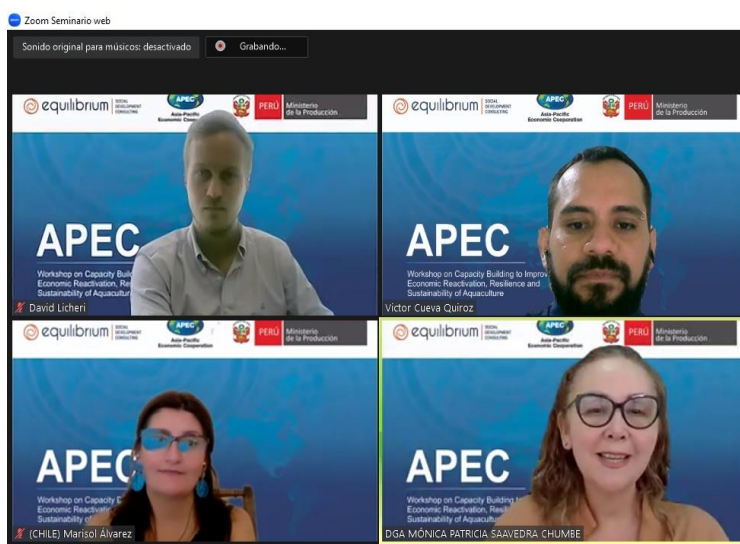


MINUTA
OBSERVACIONES A LAS RESPUESTAS DE LA ENCUESTA DEL
PROYECTO OFWG 05-2021 “REPORT AND WORKSHOP ON CAPACITY
BUILDING FOR IMPROVEMENT OF ECONOMIC REACTIVATION IN
SUSTAINABLE AQUACULTURE”

Official responses from the Government of Chile to the designed questionnaire.

Covid-19 impact in the aquaculture sector	Strategy for improving the production efficiency	
<ul style="list-style-type: none"> • Lockdown measure of major importing countries of fishery products • Economically important aquaculture species are most affected • Decline in demand for seafood consumption due to lockdown measures within the country • Delay of raw material transportation • Seafood export and import have been declined • Increasing consumer's demand for prepare seafood products that can be preserved for longer periods • Expansion of online trade of fishery product 	<p>Measure #1</p> <ul style="list-style-type: none"> • Aquaculture relate Technology and Innovation <ul style="list-style-type: none"> – Solar cell – Water quality test applications – Automatic feeders – Smart aerators • Big data 	<p>Impacts</p> <ul style="list-style-type: none"> • Keep aquaculture farmers from changing their occupation • Reduce production costs • Enable the farmers to plan the production for each crop to prevent excessive supply enter into the market that could lower of the price of fish • Reduce the role of middleman

Remarks from the presentation by Ms. Jitlada Srirakul, Fisheries Development Policy and Planning, Department of Fisheries, Ministry of Agriculture and Cooperation of Thailand.



Final discussion from Session II of the workshop with participation of Marisol Alvarez Head of the Management and Policies Unit, Aquaculture Division, Undersecretary of Fisheries and Aquaculture (SUBPESCA) from Chile and Monica Saavedra Chumbe, Director of the General Direction of Aquaculture, Ministry of Production (PRODUCE) from Peru and moderators.