Food and Agriculture Organization of the United Nations

Realizing aquaculture's Blue Economy potential in the Pacific Islands region

Enabling conditions, barriers and next steps

CONSERVATION INTERNATIONAL

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Executive summary

This report was conducted during the United Nations International Year of Artisanal Fisheries and Aquaculture (IYAFA) (FAO, 2022c) in recognition of the millions of small-scale fishers, aquaculture farmers, and seafood workers that provide essential nutrition to billions globally. With support and guidance from the Food and Agriculture Organization of the United Nations (FAO), specifically FAO's Regional Office for Asia and the Pacific (FAO RAP) and FAO's Subregional Office for the Pacific Islands (FAO SAP), this work contributes to FAO's Aquaculture Regional Technical Platform (AQ-TRP) (FAO, 2022a) to identify challenges and issues to be addressed for the future development of sustainable aquaculture in the Pacific Islands region.

Although many Pacific Island countries (and territories) have conducive physical environments for aquaculture, the industry has remained mostly under-developed, with stagnant or declining production volumes (FAO, 2022b) and growth rates that are lagging behind many other aquaculture-producing regions (De Silva and Yuan, 2022). Certain production systems and species have shown some socioeconomic benefits, but a lack of coordinated interventions (i.e. those that align environmental and social benefits with economic development throughout the supply chain and with government and financial institutions) are preventing the aquaculture sector from achieving greater potential. This report subsequently identifies the enabling conditions for sustainable aquaculture development more broadly and uses these factors to benchmark the aquaculture sector in the Pacific Islands region.

Aquaculture production systems are categorized pairwise by feeding type and end-market (e.g. fed domestic, unfed domestic, unfed for export, fed for export) to better understand the industry landscape and identify key characteristics that differentiate systems. The enabling conditions for sustainable and equitable aquaculture production are then outlined as input, production, and output attributes that need to be met, or would otherwise inhibit growth and/or jeopardize environmental sustainability, social responsibility, and long-term economic viability. Key challenges and opportunities based on these enabling conditions within the Pacific Islands' context suggest that while some production systems (e.g. unfed and fed species for domestic consumption) could be enhanced with the help of coordinated interventions, others (e.g. fed species for export) have substantial barriers to overcome.

Three production systems within specific Pacific Island countries have been selected as example aquaculture sectors that could show promise towards a sustainable and prosperous industry. Multicoloured and Mabé pearls in Fiji (i.e. unfed for domestic and export), seaweeds and sea grapes in Samoa (i.e. unfed domestic and export), and tilapia in Solomon Islands (i.e. fed domestic) have exemplified strengths in certain enabling conditions and are likely to achieve higher growth potential and socioeconomic contributions with coordinated interventions to address remaining challenges.

Jurisdictional approach improvement programmes have been implemented for terrestrial commodity supply chains, such as palm oil in Malaysia and Indonesia as well as soy in Brazil (Buchanan *et al.*, 2019) and is an emerging strategy in the aquaculture sector which aims to align producers, governments, supply chains, and financial institutions within a geographic and/or political boundary (i.e. the "Jurisdiction") towards environmental sustainability, social responsibility, and economic development. Rather than piecemeal projects or narrowly focused activities within a specific supply chain that may only address certain stakeholder groups or environmental impacts, jurisdictional approach interventions are a holistic approach to align stakeholder groups towards a common goal to improve multiple, unmet enabling conditions for an entire production system. Although these types of interventions would be specific to an identified aquaculture commodity, such as in the examples provided, improved enabling conditions for the aquaculture sector would likely transfer benefits to other production systems. An aquaculture jurisdictional approach intervention would require:

- scoping to identify key economic, environmental, and social challenges of the specific aquaculture system proposed for development;
- co-design by all participating stakeholders to ensure project success;
- implementation amongst those stakeholders against a time bound work plan; and
- indicators that show that identified economic, environmental, and social challenges have been mitigated or realized.

Recommendations for each example commodity are provided as actionable steps to address unmet enabling conditions, however, common gaps across these production systems highlight deficiencies where targeted interventions may help to improve the sector more broadly. The report identifies four barriers where sector actors can take action to advance aquaculture in the Pacific Islands region:

- improve access to finance and financial tools that encourage sustainable production;
- create a more conducive regulatory environment;
- improve access to and utilization of best management practices and technology; and
- improve access to markets.

Findings from this report are meant to provide a pathway that can be adapted and applied to a variety of species, geographies, and communities across the Pacific Islands region and beyond. No single entity, intervention, or actor will be able to catalyse the industry alone but quite the contrary – only when coordinated efforts are in alignment will the enabling conditions for sustainable aquaculture development be met and the sector will grow sustainably.

1. Introduction

Climate change, overfishing, destructive fishing methods, market instability and pollution all threaten the food security and livelihoods of coastal and island communities around the world, especially in Small Island Developing States (SIDSs) (FAO, 2018a; Gaines *et al.*, 2019; FAO, 2020). Pacific Islands countries are no exception, and integrated management solutions to address and adapt to these threats are needed to create a sustainable and prosperous future. Livelihoods in the Pacific Islands region are largely dependent on aquatic resources to contribute to income, food security, the provision of nutrition and health benefits, support for cultural identity and practices, and to connect people with their environment (Stacey and Govan, 2021). Sustainable aquaculture is increasingly seen as a viable option to meet the food security and livelihoods needs of the Pacific Islands region (Amos *et al.*, 2014), but additional financial and technical support is required to unlock the full potential of the sector (SPC, 2021b).

This report offers insights into current aquaculture developments in the Pacific Islands region by identifying challenges, opportunities, barriers to growth and enabling conditions that characterize the landscape of the sector. Finally, it provides potential strategies which can support the sustainable growth of aquaculture, including examples from three representative geographies.

Section 1 of the report provides production volumes and values for aquaculture products across all Pacific Island countries (and territories) to provide context and regional trends. The report proceeds to specifically focus on FAO Member Nations of the Cook Islands, Fiji, Federated States of Micronesia, Kiribati, Nauru, Niue, Palau, Papua New Guinea, the Marshall Islands, Samoa, Solomon Islands, Tonga, Tuvalu, and Vanuatu.

1.1 Aquaculture in the Pacific Islands

1.1.1 Main species/systems by volume and value

Aquaculture production across Pacific Islands Countries (and Territories) include a broad range of species and production systems that contribute to food security, livelihoods and economic development, as well as providing social and environmental value. Although aquaculture is diverse in its production types and socioeconomic contributions, the sector has grown slower in the Pacific Islands region than in other parts of the world, in part due to the abundance of local wild capture fish, high aquaculture production costs, and relative low market value of commonly available aquaculture species (UN ESCAP, 2020). Growth and development of the sector is further inhibited by a general lack of production and trade data. For example, the sector in Fiji is highly dispersed with few or no records of harvest, evidence of conflicting statistics across data sources, and data that have been obscured for commercial secrecy (Robert *et al.,* 2016; Graham and D'Andrea, 2021). These types of data discrepancies or inaccuracies, where accurate production estimates are not reflected in official statistics, may obscure the actual diversity and abundance of aquaculture production, preventing informed planning, management, and research of the aquaculture sector (Froehlich *et al.*, 2022).

Based on International Standard Statistical Classification for Aquatic Animals and Plants (ISSCAAP) Divisions, Aquatic Plants (e.g. seaweeds) production across Pacific Islands Countries (and Territories) over the last ten years has consistently been the largest aquaculture division by volume, reaching a peak of 23 230 tonnes in 2014 but slumping to just 10 065 tonnes in 2020 (FAO, 2022b). This category is made up of red algae (e.g. seaweeds) primarily for further processing as carrageenan. In addition to seaweeds, other significant aquaculture divisions include freshwater fishes, crustaceans, and miscellaneous aquatic animal products (**Figure 1**). Both freshwater fishes (i.e. mainly tilapia [*Oreochromis* spp.] with some smaller volumes of carps [*Cyprinus* spp.]) and crustaceans (e.g. *Penaeus* spp.) have stayed at relatively consistent volumes over the last ten years, currently at 1 881 tonnes and 1 722 tonnes, respectively (FAO, 2022b). Miscellaneous aquatic animal products (i.e. pearl oysters [*Pinctada* spp. and *Pteria penguin*]) have experienced a steady decline from 2 868 tonnes in 2011 down to 1 210 tonnes in 2020 (FAO, 2022b). Smaller volumes of diadromous fishes (e.g. rainbow trout [*Oncorhyncus* mykiss] and milkfish [*chanos chanos*]), marine fishes (e.g. rabbitfishes [*Siganus* spp.], groupers [*Epinephelus* spp.], and cobia [*Rachycentron canadum*]), and molluscs (e.g. giant clams [*Tridacna* spp.]) are produced, while miscellaneous aquatic animals (i.e. seacucumber or sandfish [*Holothura scabra*]) were only reported for 2018 (100 tonnes) and 2019 (39 tonnes) (**Figure 1**) (FAO, 2022b).

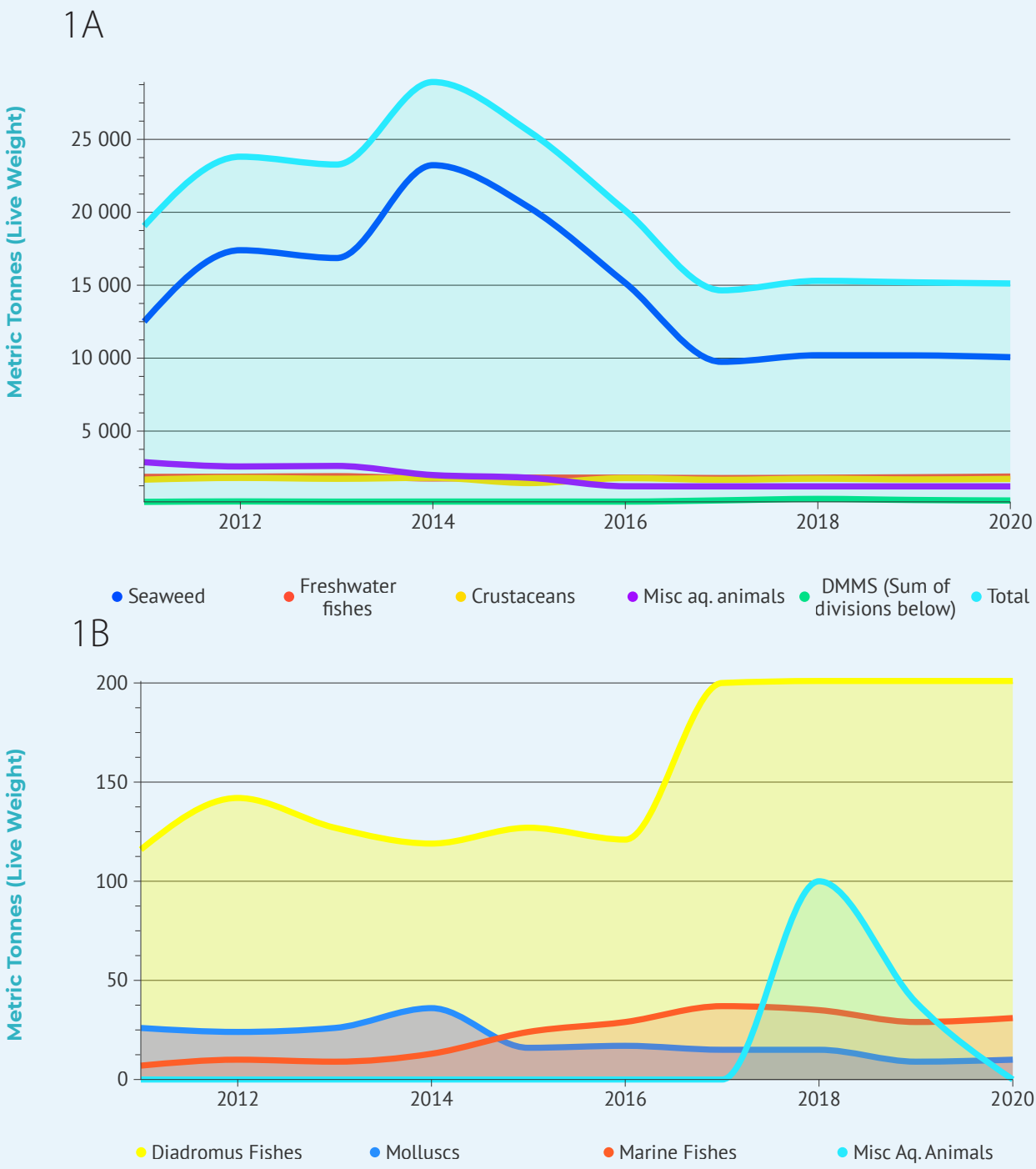


Figure 1. Aquaculture production in metric tonne live weight by ISSCAAP Division from 2011-2020

Notes: "Aquatic Plants" is categorized here as "Seaweeds". "Misc. Aq. Animal Products" includes oysters producing pearls and shells. "Misc. Aq. Animals" includes sandfish (i.e. sea cucumbers). "DMMM" in Figure 1A includes the sum total of diadromous fishes, marine fishes, miscellaneous aquatic animals, and mollucs which is further broken down by Division in Figure 1B.

Source: FAO. 2022b. "Fishery and Aquaculture Statistics. Global Aquaculture Production 1950-2020 (FishStatJ). FAO Fisheries and Aquaculture Division (online). www.fao.org.fishery/statistics/software/fishstat/en.

Total aquaculture production across the Pacific Islands Countries (and Territories) for 2020 had an estimated value of USD 92.5 million, a modest increase from the USD 90 million in value produced in 2019 (FAO, 2022b). French Polynesia is the largest value generator at over USD 62 million, accounting for over 67 percent of the Pacific Islands region's total aquaculture value – primarily from blacklip pearl (*Pinctada margaritifera*)

production. New Caledonia follows at USD 18.7 million (20 percent of total), with Papua New Guinea in third at USD 7.7 million (8 percent of total). Fiji, Guam, and the Marshall Islands each contribute about 1 percent in total value, at USD 1.2 million, USD 0.99 million, and USD 0.85 million, respectively. A large difference in production value exists between territories, such as French Polynesia and New Caledonia, in respect to the rest of the Pacific Islands region, with territories producing almost 90 percent of the total aquaculture production value. This is a result of substantial resource allocation, including government intervention and a conducive regulatory environment, through time dedicated to research and development of aquaculture systems which have met international and domestic market needs.

Blacklip pearl oyster production (i.e. miscellaneous aquatic animal products), driven by French Polynesia and New Caledonia, generated the highest value at over USD 58.8 million in 2020 and representing almost 64 percent of total value. These types of products, however, accounted for only 1 210 tonnes (eight percent of total live weight volume). Crustaceans followed at an estimated USD 23.1 million and 25 percent of value, with 1 722 tonnes. Freshwater fishes and diadromous fishes were much lower at USD 6.9 million (seven percent) and USD 2.1 million (two percent), respectively. Molluscs, seaweeds, and marine fishes each contributed less than 1 percent of total value. Blacklip pearl oysters and pearl oyster shells, crustaceans, and freshwater fishes are the highest value generating aquaculture categories, and while seaweeds are produced in the highest volumes, are generally of lower overall value (**Figure 2**).

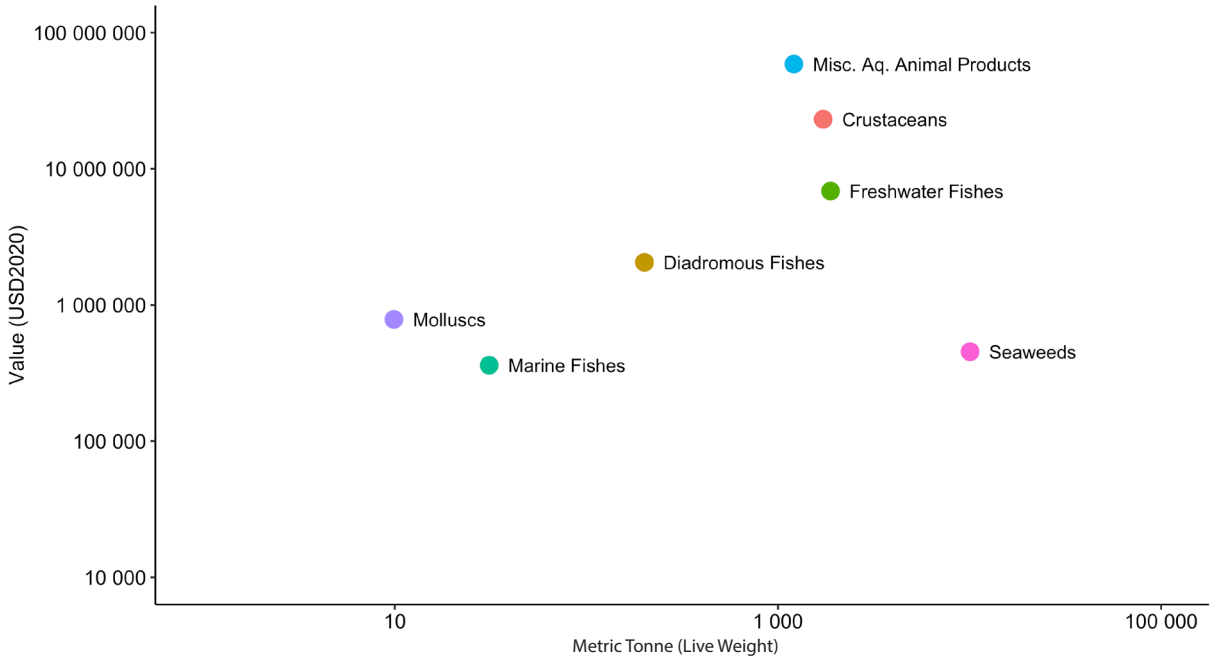


Figure 2. Aquaculture production in metric tonnes live weight and value in USD2020 by ISSCAAP Division for the year 2020

Notes: "Aquatic Plants" is categorized here as "Seaweeds". "Misc. Aq. Animal Products" includes oysters producing pearls and shells.

Source FAO. 2022b. "Fishery and Aquaculture Statistics. Global Aquaculture Production 1950-2020 (FishStatJ). FAO Fisheries and Aquaculture Division (online). www.fao.org.fishery/statistics/software/fishstat/en.

1.1.2 Growth of sector

Aquaculture growth in the Pacific Islands region has always lagged behind global trends. Global aquaculture production continued record high growth with over 114 million tonnes in 2018, and a farm gate value estimated to be over USD 263 billion (FAO, 2020). Production continued to grow in 2019 to almost 120 million tonnes, and to over 122 million tonnes in 2020, achieving over 50 percent growth from the 80 million tonnes produced in 2010 (FAO 2021a; 2022b). In contrast, FAO production statistics reported for the most recent year (2020) across the PICTs indicate that production by volume (metric tonne in live weight) across the region was 15 120 tonnes with the top producing countries being Papua New Guinea (6 102 tonnes), Solomon Islands (5 504 tonnes), New Caledonia (1 478 tonnes), French Polynesia (1 371 tonnes), and Fiji (322 tonnes) (**Figure 3**), and the remaining thirteen countries producing a combined total of 340 tonnes (**Figure 4**).

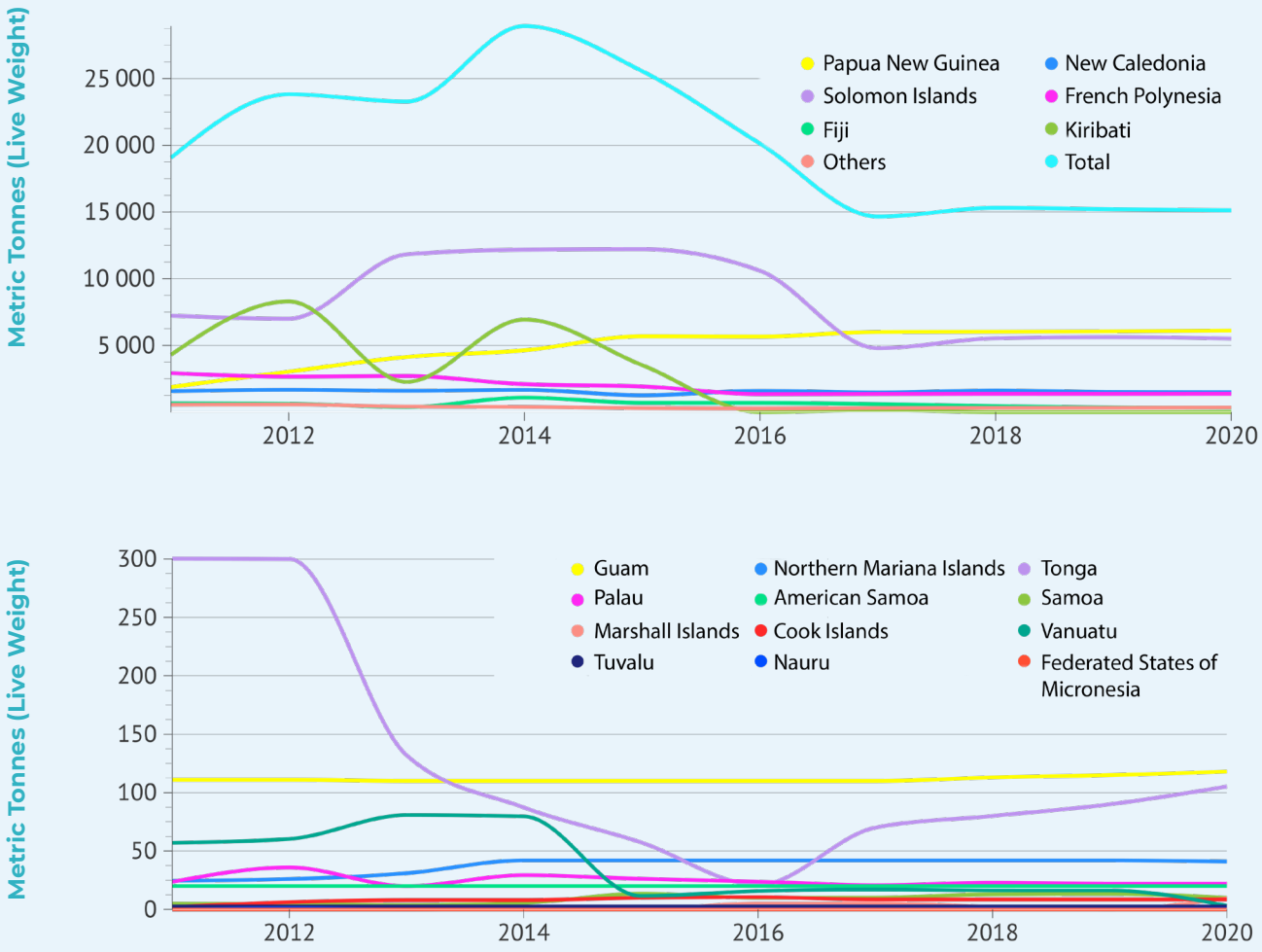


Figure 3 and 4. Aquaculture production in tonnes live weight by country across the Pacific Island Countries and Territories (PICTs) between 2011-2020

Source: FAO. 2022b. "Fishery and Aquaculture Statistics. Global Aquaculture Production 1950-2020 (FishStatJ). FAO Fisheries and Aquaculture Division (online). www.fao.org.fishery/statistics/software/fishstat/en.

Driven largely by seaweed production, the Pacific Islands Countries (and Territories) reached peak aquaculture production in 2014 at 28 933 tonnes but has since seen a general decreasing trend in total volume outputs. For example, Kiribati was producing up to 8 280 tonnes of *Euchema* seaweeds in 2012 but has reported zero production for the period between 2018 and 2020. Solomon Islands have also experienced large fluctuations in volume from as high as 12 200 tonnes in 2015 to its most recent report of 5 504 tonnes in 2020 as a result of decreasing seaweed production. *Kappaphycus* production in the region has declined since the 2000s, largely due to strains that are inadequate for warming waters, poor farm management practices, poor product quality, as well as export pricing and transportation issues (ACIAR, 2020). Conversely, Papua New Guinea has seen steady growth of its aquaculture sector over the last ten years, mainly driven by tilapia production (FAO, 2022b).

1.1.3 Role in economy

Published information regarding aquaculture in the Pacific Islands region's contribution to economic output metrics, such as employment and gross domestic production (GDP) is limited. Calculated estimates based on national GDP (World Bank, 2022; UNCTAD, 2022) and aquaculture values (FAO, 2022b) indicate that aquaculture generally contributes less than one tenth of a percent to GDP and many Pacific Islands Countries (and Territories) have had slightly decreasing contribution trends over the last ten years (**Figure 5**). Relevant information regarding number of farm units and employment in some countries have previously been documented but is in need of updated information. For example, 5 400 small-scale fish ponds were recorded based on fingerling distribution in Papua New Guinea between 2001 and 2006, although the actual number of active ponds could have been as high as 10 000—15 000 (Smith 2007; ACIAR 2016). Other accounts have estimated that Papua New Guinea has the largest number of farms in the region at 2 500 with 3 000 persons (mostly artisanal aquaculturists), followed by French Polynesia at 530 farms and 5 000 persons employed, the Cook Islands with 80 farms and 450 persons employed, Fiji with 50 farms and 280 persons employed, and New Caledonia with 40 and 560 persons employed (Ponia, 2010).

Other important but outdated data come from (Pickering *et al.*, 2011) which state that pearl farming in French Polynesia represents 66 percent of the combined value of fisheries and aquaculture production, however, it contributes less than one percent to the national GDP. This situation is similar in New Caledonia where shrimp farming contributes 33 percent to the combined value of production from fisheries and aquaculture but contributed less than one percent to the national GDP. Species-specific studies on the socioeconomic role of aquaculture products continue to be published (e.g. trochus, (Gillett *et al.*, 2020), and seaweed, (ACIAR, 2020) but updated data on the sector as a whole are needed to assess the current, detailed impact of aquaculture on national economies. Available metrics indicate that the sector is small relative to other parts of the economy, and in some instances uneconomic for small scale producers in the Pacific Islands region if only measured in monetary terms (Lindsay *et al.*, 2022).

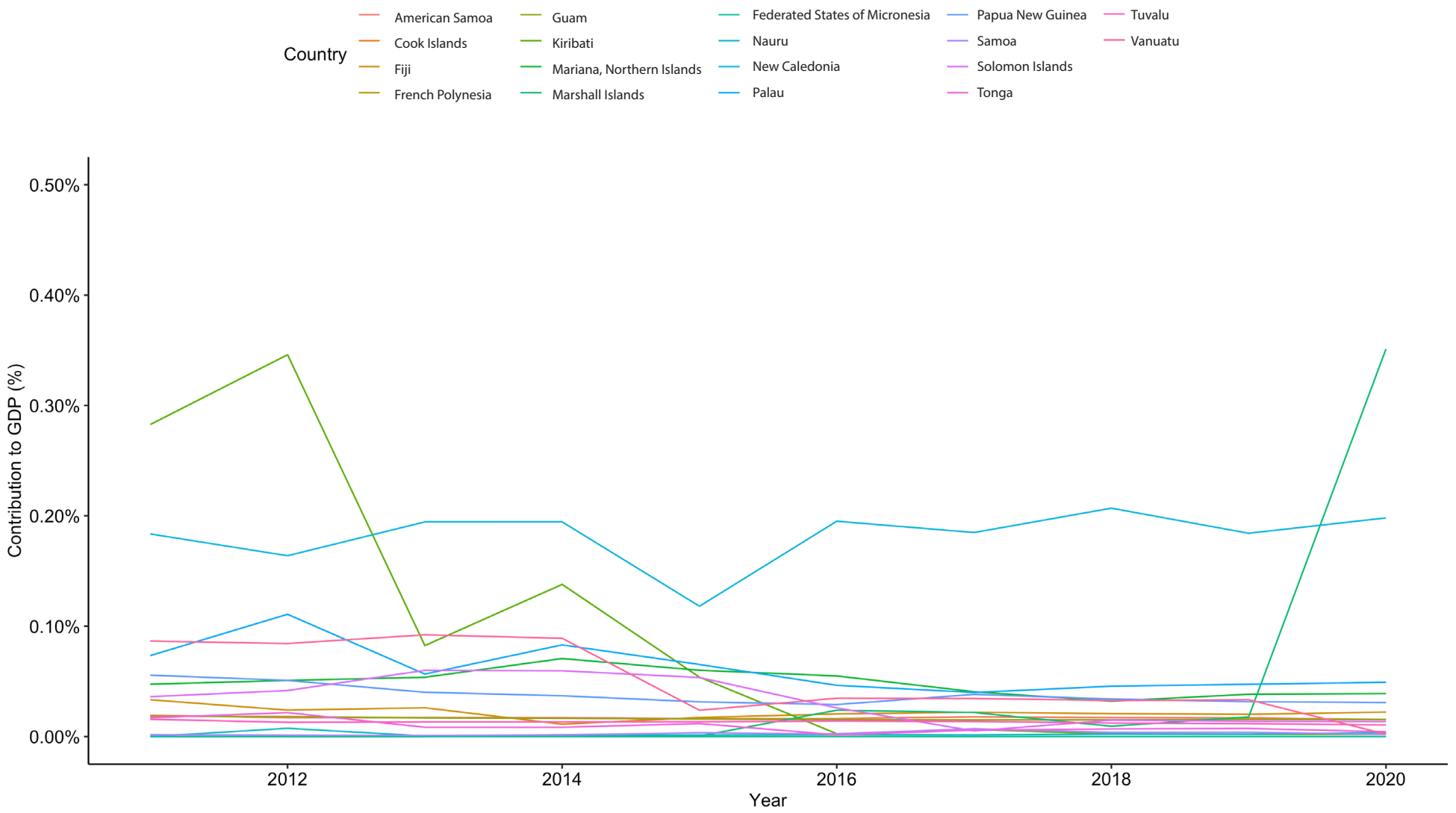


Figure 5. Relative contribution of aquaculture to national GDP for PICTs from 2011 to 2020

Sources: The World Bank. 2022. World Bank National Accounts Data. World Development Indicators. https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?end=2020&locations=FJ-KI-MH-FM-NR-PW-PG-WS-SB-TO-TV-VU&start=2009; UNCTAD. 2022. UNCTAD Stat. United Nations Conference on Trade and Development. Switzerland. http://unctadstat.unctad.org/EN/Index.html; FAO. 2022. "Fishery and Aquaculture Statistics. Global Aquaculture Production 1950-2020 (FishStatJ)." FAO Fisheries and Aquaculture Division (online).

1.1.4 Regional and national policies/strategies overview

The main regional policy which addresses the development of aquaculture in the Pacific Islands is the Pacific Community (SPC) Regional Aquaculture Strategy 2013-2017, which identifies 6 priority improvement areas (SPC, 2013):

1. **Biosecurity:** production and transfer of aquatic organisms with minimum biosecurity risks.
2. **Capacity building:** improved capacity at all levels among Pacific Island Countries and Territories (PICTs) to develop aquaculture and manage strategic and technical issues.
3. **Feasibility assessment:** commercial and noncommercial aquaculture that is economically, socially, and environmentally viable with sustained and stable production.
4. **Statistics and data:** improved aquaculture policy and decision-making through the provision of knowledge of status, contributions, and trends in the aquaculture sector.
5. **Markets and trade:** increased trade [domestic and export] in Pacific aquaculture products.
6. **Technology transfer and improvement:** improved production efficiency through adoption of appropriate, proven technology.

The strategy also addresses cross-cutting areas such as gender, capacity building, climate change and environmental sustainability, governance, and research. The regional strategy is currently being reviewed and an updated version will soon be published.

Two other SPC regional policies include aquaculture as an alternative model to enhance food security and livelihoods in the Pacific Islands region. The Noumea Strategy includes aquaculture as an intermediate outcome related to diversifying livelihoods, reducing pressure on fisheries resources, enhancing community incomes, and contributing to improved fisheries management (SPC, 2015). Similarly, A Regional Roadmap for Sustainable Pacific Fisheries defines aquaculture as an alternative livelihood future potential option for coastal communities that are impacted by declining fisheries resources (FFA and SPC 2015).

Building from these regional frameworks, several Pacific Islands Countries (and Territories) have developed strategies specific to aquaculture growth and/or have coastal fisheries policies and strategies that include aquaculture as a priority for future livelihood and food security. A summary of the main objectives and outcomes set out in these national strategies are provided in **Annex 1**. Tonga is the only Pacific Islands Countries (and Territories) with a current Act dedicated entirely to aquaculture, while Fiji has a Bill which has yet to be passed by Parliament. However, several Pacific Islands Countries (and Territories) have clear objectives and goals specific for aquaculture development enlisted in strategic plans: the Cook Islands, Fiji, Federated States of Micronesia, Papua New Guinea, Samoa, Solomon Islands, and Tonga. Updated regional

and country-specific strategies that stimulate aquaculture development are recommended to help guide the industry towards prosperous growth that supports food security and livelihoods, while providing environmental, social, and economic safeguards.

1.2 Objective of this study

This report is aligned with and contributes to the implementation of two FAO strategic objectives:

- **Strategic objective 2:** Make agriculture, forestry, and fisheries more productive and sustainable, specifically by "supporting producers in adopting more productive, sustainable, and climate-resilient practices".
- **Strategic objective 4:** Enable more inclusive and efficient agricultural and food systems by "promoting agribusiness finance and investment".

Moreover, the outcomes are in line with FAO's vision of a sustainable and food secure world for all embodied by FAO four betters: better production, better nutrition, a better environment, and a better life (FAO, 2021b).

The primary objectives of this report are to:

- provide an overview of current trends, challenges, and opportunities of aquaculture sectors in the Pacific Islands region;
- identify barriers to growth of the aquaculture sector and the enabling conditions and actionable steps necessary to mobilize investments; and
- identify strategic directions for three identified Pacific Islands countries in which sustainable growth of aquaculture sector is feasible, including list of main stakeholders and potential investors.

1.3 Methodology of this study

This report has been produced through a desktop review of peer-reviewed and grey literature, and through interviews with regional organizations (e.g. ACIAR, SPC FAME, and CI) which focus on aquaculture development in the Pacific Region.

Section 1 presents an overview of the current aquaculture production and value, growth, role in economy, and governance taking in consideration all the Pacific Islands including western overseas territories such as New Caledonia, French Polynesia, and American Samoa. The rest of the report focuses only on the Pacific Islands Countries (and Territories) which are Members of FAO: the Cook Islands, Fiji, Federated States of Micronesia, Kiribati, Nauru, Niue, Palau, Papua New Guinea, the Marshall Islands, Samoa, Solomon Islands, Tonga, Tuvalu, and Vanuatu.

Section 2 presents the aquaculture products which have been divided into four different categories for this report's purpose: domestic, export, fed, and unfed.

Section 3 defines the enabling conditions (Bunting *et al.*, 2022) which will be used to identify the countries in which sustainable aquaculture development is currently possible.

Section 4 enlists the challenges and opportunities related to aquaculture development in the Pacific Islands connected to the enabling conditions defined in Section 3.

Section 5 focuses on the stakeholders which are involved in aquaculture development in the Region.

Sections 6 and 7 offer potential strategies for three countries which have met the enabling conditions and potential recommendations and next steps for the future development of aquaculture.

2. Archetype potential aquaculture products for growth ensuring food security and livelihood in the Pacific Islands

2.1 Production categories: domestic vs export; fed vs unfed

The global aquaculture sector is highly diverse (e.g. approximately 443 species were cultured in 2019 (FAO, 2021a), and different species and production systems pose unique trade-offs in terms of opportunities and challenges for growth in the Pacific Islands region, including provision of livelihoods, food security, and other services. Despite the diversity in the sector, similar attributes are often shared between species that are fed versus unfed and destined for domestic versus export markets.

Fed species (e.g. many fish and crustaceans) require nutrient inputs, which can include a range of feed ingredients from agricultural products to food wastes to fishmeal and fish oil. Unfed, or extractive, species (e.g. seaweeds and molluscs) are able to utilize and extract nutrients from the water and do not require supplemental feed. Fed and unfed aquaculture have distinct production requirements, livelihoods contributions, food security benefits, and environmental interactions that may serve as potential opportunities or challenges within the Pacific Islands region.

Additionally, the end market (e.g. local markets or for export) of aquaculture products can approximate the contribution of aquaculture to livelihoods and food security. Aquaculture products that remain primarily within the country are more likely to be of lower price points and directly support nutritional and food security needs, especially in nutritionally vulnerable nations (Golden *et al.*, 2017). Species such as Nile tilapia

(*Oreochromis niloticus*) and milkfish are commonly sold in domestic markets to meet local food security needs, whereas pearls and shells from oysters, some types of seaweed, marine ornamentals, marine shrimps, and some finfish are types of cultivated species that target export markets, have higher price points, and therefore support stronger livelihoods benefits (Amos *et al.*, 2014).

2.2 Production category profiles

While there are hundreds of current and potential species that could be evaluated for production in the Pacific Islands region, we use four archetypes that pair production and end-market to evaluate the potential of aquaculture to meet livelihood and food security needs. We identify the primary production archetypes in the Pacific region as: *fed aquaculture for domestic markets, unfed aquaculture for domestic markets, unfed aquaculture for export markets, and fed aquaculture for export markets* (**Figure 6**).

	Domestic	Export
Unfed	Pear oyster(black-lipped, etc.) Giant clams Seaweeds (e.g. sea grapes) Stock enhancement	Pear oyster(black-lipped, etc.) Giant clams Seaweeds (e.g. *kappaphycus*) Aquarium/ornamental
Fed	Tilapia Milkfish Other (e.g shrimp, trout, carp)	Pinaeid shrimps Aquarium/ornamental

Figure 6. Schematic of the four aquaculture archetypes

Source: Elaborated by authors.

Fed domestic

Fed aquaculture species for domestic markets have direct contributions toward food security as these species are primarily grown for subsistence or sold at local markets. Some fed species, especially inland freshwater fish (e.g. carp, tilapia, catfish, etc.) are likely to provide direct food and nutritional benefits for many growing and nutritionally vulnerable populations (Belton and Thilsted 2014; Golden *et al.*, 2017; Harohau 2020). Although these species have been well-documented to provide protein and micronutrients, their requirement for supplemental feed needs to be considered–including manufacturing, storage, and embedded negative environmental impacts of ingredients. Tilapia is increasing in production across the Pacific Islands region (Amos *et al.*, 2014; Johnson *et al.*, 2017; ACIAR, 2019b), while milkfish has experienced a steady decline over the last 10 years, in part, due to its dependence on collecting wild juveniles and limited coastal areas for production (Amos *et al.*, 2014; Robert Doyle Gillett 2016; Johnson *et al.*, 2017). Fed species for domestic markets are also diversifying to include commercial trout and carp production in Papua New Guinea (Amos *et al.*, 2014) and some private sector shrimp culture to support tourism (UN ESCAP, 2020).

Unfed domestic

Aquaculture production that utilizes resources that do not rely on supplemental feed and formulated diets, but can instead be grown from nutrients in the natural aquatic ecosystem (e.g. filter feeding by bivalves,

primary production by seaweeds, foraging by baitfish, etc.) take advantage of aquatic resources that would otherwise not be accessible by humans (Troell *et al.*, 2014). Aquaculture species that are less resource-demanding will have lower direct and indirect environmental impacts, but their uptake can be challenged by market demand (Henriksson *et al.*, 2021). Current and potential unfed aquaculture species grown for local markets or domestic use include Black-lipped pearl oysters (Amos *et al.*, 2014), edible seaweeds (e.g. *Caulerpa, Hypnea, Ulva, and Gracilaria*) (ACIAR, 2020), and numerous hatchery-reared species (e.g. giant clam, trochus, sea cucumbers, corals, and others) for ocean grow-out and restocking programmes (Johnson *et al.*, 2017).

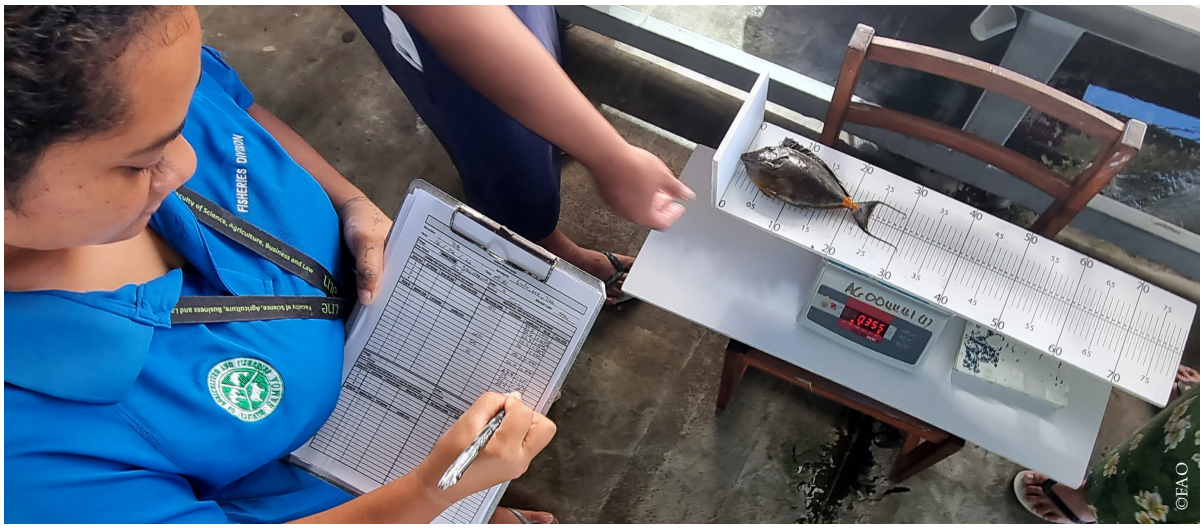
Unfed aquaculture species have their own production challenges that could limit growth potential. Although there is some production of unfed species in ponds, tanks, or in other land-based systems, the largest opportunity for seaweed and shellfish growth lies in marine production (e.g. mariculture) (Theuerkauf *et al.*, 2019). Aquaculture production in open systems allow for the extraction of nutrients from ambient marine waters, but also makes the produced species and infrastructure vulnerable to the surrounding physical, biological, and chemical conditions.

Unfed export

In some cases, unfed or extractive species, can provide additional ecosystem services beyond their intended income or food benefits (Gentry *et al.*, 2020). Bivalve and seaweed production that provides direct ecological benefits have been termed "Restorative Aquaculture or Regenerative Aquaculture" and its implementation could help to address ocean acidification risks (Theuerkauf *et al.*, 2019). Infrastructure for unfed aquaculture provides habitat that could increase wild catch and contribute to food security (Barrett *et al.*, 2022). Aquaculture products destined for export from the Pacific Islands region are primarily seaweed (Johnson *et al.*, 2017; ACIAR, 2020; UN ESCAP, 2020), blacklip pearl oysters (Robert Doyle Gillett, 2016), and those for the ornamental and aquarium trade, including corals, sponges, live rock, trochus, and giant clam species (Gillett, 2016, and: Gillett *et al.*, 2020).

Fed export

Export-oriented aquaculture can theoretically help address poverty through export revenues and national economic growth, however supporting evidence can be difficult to determine, especially in situations where aquaculture exports contribute relatively small fractions of GDP to larger and more diverse economies (Béné *et al.*, 2016). The benefits of exported aquaculture products will be context-dependent, although these types of products are unlikely to have substantial contributions to local nutrition since most export-oriented products target higher price point species for international trade (Golden *et al.*, 2017). Coordinated government intervention, armed with reliable national and regional trade data can help to guide aquaculture growth to ensure equitable resource allocation and coordinate among aquaculture production, wild-capture fisheries, and seafood imports. Accounts of fed species for export (e.g. finfish, prawns, ornamental species, etc.) have been recorded anecdotally but are not currently being produced in significant volumes.



3. Enabling conditions for sustainable production

Enabling conditions for sustainable and equitable development of aquaculture include broad attributes of environmental sustainability, social equity, and economic viability (Cisneros-Montemayor *et al.*, 2021), and a more detailed accounting of enabling conditions has been developed at the individual farm level and the sectorial level.

Farm-level enabling conditions for sustainable production have been described in a multitude of sources and are most accurately reflected in international certification standards such as the Aquaculture Stewardship Council (ASC) standard and the Global Seafood Alliance's Best Aquaculture Practices (BAP) standard. These standards broadly assume that the farms are economically viable and focus primary on environmental sustainability and social aspects (**Table 1**). The sustainability of individual farms can be measured against these standards.

BAP farm standard	ASC farm standard
Food safety	Legal and effective business management
Social accountability	Social responsibility
Environmental responsibility	Environmental responsibility
Animal health and welfare	
Traceability	

Table 1. Enabling conditions for farm level sustainability, as expressed in the BAP and ASC farm standards

Source: BAP. 2021. "Aquaculture Facility Certification: BAP Farm Standard." Global Aquaculture Alliance Best Aquaculture Practices. ASC. 2022. "Alignment: ASC Farm Standard." ASC-AQUA.ORG. 2022. https://www.asc-aqua.org/programme-improvements/aligned-standard/.

Sustainable development of multiple aquaculture operations in a single, connected area requires sector-level enabling conditions. Sectorial enabling conditions are broadly defined in FAO's Ecosystem Approach to Aquaculture concept, including spatial planning, coordinated disease management, and inclusive, effective governance (Soto, Aguilar-Manjarrez, and Hishamunda, 2008; Aguilar-Manjarrez *et al.*, 2017; Bone *et al.*, 2018). Spatial planning and coordinated disease management enable aquaculture operations across a region to realize sustainable production, including improving human wellbeing with minimal impacts to ecosystems and biodiversity (Soto *et al.*, 2008). Financial markets can also enable and incentivize sustainable production practices through redirecting harmful subsidies, aligning economic incentives, improving insurance, and catalysing new investments (Sumaila *et al.*, 2021).

Another way to evaluate enabling conditions across an aquaculture sector is to consider attributes of the inputs, production environment, and outputs across the sector (**Table 2**). If any of these attributes are lacking across the sector, production may not grow or might grow in a manner that does not realize environmental sustainability, social responsibility and long-term economic viability.

Inputs	Production	Outputs
Access to seed	Conducive physical environment	Access to processing
Access to feed	Conducive regulatory environment	Access to markets
Access to finance	Access to and utilization of best management practices and technology	Efficient utilization of outputs
Access to labour	Social license	
	Efficient natural resource use	

Table 2. Enabling conditions for the sustainability of aquaculture operations

Source: **Bunting, S, Pounds, A., Immin, A.k, Zacari, S., Bulcock, P., Murray, F., and Auchterlonie, N.** *2022. The Road to Sustainable Aquaculture: On Current Knowledge and Priorities for Responsible Growth. World Economic Forum. https://www3.weforum.org/docs/WEF_The_Road_to_Sustainable_Aquaculture.pdf*

Access to inputs that are functional and cost-effective is critical to growth and operations of the aquaculture sector. Access to quality seed can increase survival rates and yields. Well-managed hatcheries and selective breeding programmes can increase farm performance, including faster growth rates and reduced disease risks. Access to quality, affordable feed can increase environmental and economic performance of operations. Access to finance can help farms adopt best practices and technology utilization, increasing profitability and performance. Access to skilled, cost-effective labour is also critical for execution of best management practices and effective farm operation.

Production conditions must also be suitable for growth of farms and the sector. The physical environment must be conducive to growth of culture organisms, including sufficient water quality and alignment with other environmental parameters (e.g. water temperature and current). Water quality monitoring and management are required at the farm level and spatial planning based on carrying capacity analyses are required at the sector level. The regulatory environment must also be conducive to sustainable operation and growth, including utilization of regulatory frameworks (e.g. policies and regulations) that are transparent, science-based, and participatory. Technology and management protocols from aquaculture sectors and other sectors (e.g. agriculture and human medicine) allow for efficient and optimized production. Social license to operate, often developed through community engagement and participation, utilization of safeguards, and clear land/marine tenure, ensures that aquaculture is aligned with and reflects the character of the community and markets in which it is located. Additionally, efficient use of natural resource inputs to aquaculture (e.g. feed and water) contribute to sustainable production by ensuring wise and efficient use of precious natural resources.

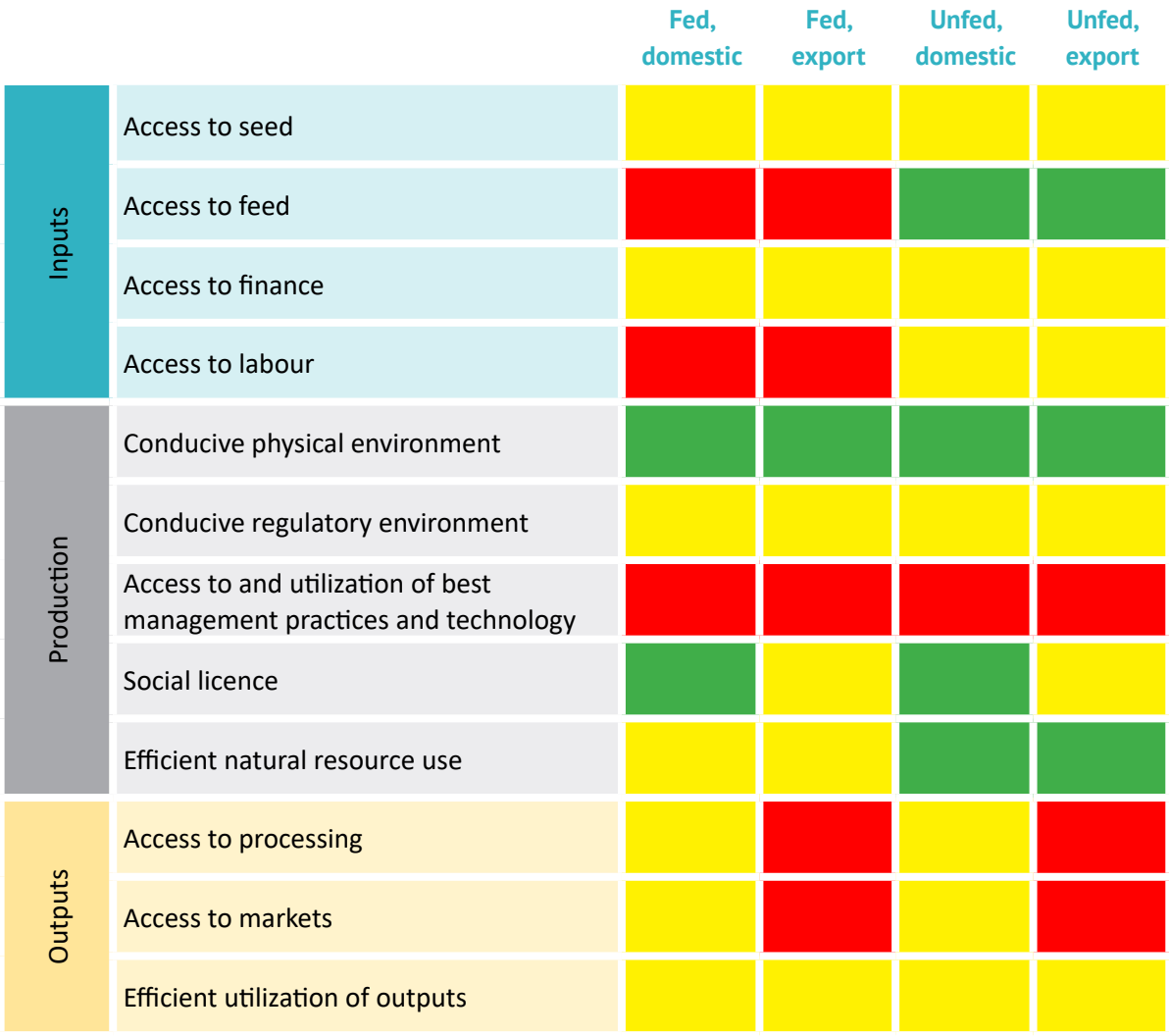
Production outputs must also have access to processing, markets, and efficient utilization opportunities for the sector to realize sustainable growth. Reliable, cost-effective processing allows producers to supply multiple markets, which reduces risk through diversification and optimizes product quality to maximize value. Local processing capacity can also provide substantial employment opportunities and opportunities for value addition. Access to markets, including physical access (e.g. suitable logistics) and economic access (e.g. price points that allow for profitability), is critical for ensuring that aquaculture is profitable and sustainable. Additionally, efficient utilization of the whole culture organism (e.g. bones, offal, etc.) and waste streams from the production process (e.g. nutrient-rich solid and liquid effluents) ensures wise and sustainable use of natural resources.

4. Challenges and opportunities of the Pacific Islands aquaculture sector– Evaluation of enabling conditions

As discussed in the introduction to this report, aquaculture development across the Pacific Islands region is undergoing varying degrees of growth, depending on policy and regulatory environments, trade priorities, consumer-demand and producer-supply preferences, as well as social and environmental constraints. Successful and sustainable livelihoods from aquaculture are dependent on the continuous availability of certain attributes including natural resource inputs, equipment, people and skills, markets, finances, and information (SPC, 2021a). Aquaculture in the Pacific Islands region can contribute to these attributes with adequate support, but Pacific Island Countries (and Territories) have experienced a wide range of opportunities and challenges.

The Pacific Islands region has several existing advantages for growing the aquaculture sector (Table 2). Pacific Islands Countries (and Territories) have relatively large exclusive economic zones and ocean and coastal environments that are conducive to increasing production of all aquaculture production categories. Unfed production (e.g. bivalves and seaweed) can also utilize abundant coastal space and nutrients to grow production in the region. Production meant for domestic markets also has the advantage of boosting local food security and therefore is more likely to have local community support.

Several obstacles must be overcome (Table 3) including poor access to inputs and markets due to the remoteness of the Pacific Islands region, which has proven to be a major barrier for the growth of aquaculture. Whether fed or unfed systems, aquaculture requires inputs, infrastructure, and adequate markets to sustain production and the physical distance between resources and larger export-oriented markets has limited growth across the region. An analysis of aquaculture in Fiji, Kiribati, Samoa, and Vanuatu identified that the main constraints facing any form of aquaculture system included access to seed, feeds, and markets (ACIAR, 2019b). Other limitations and constraints facing aquaculture in the Pacific Islands region include: transport costs/deficiencies for inputs and outputs, limited domestic markets, poor control of imported aquaculture products, lack of private sector uptake, limited policies and regulatory frameworks to grow aquaculture, lack of production knowledge of indigenous species, lack of science-based information for aquaculture commodities, and limited capacity for disease identification and management (Amos *et al.*, 2014).



Note: these characterizations are generalization and may not reflect all species farmed or countries.

Table 3. Characterization of the enabling conditions present for major production categories in Pacific Island countries as absent (red), lacking or unknown (orange), and present (green)

Source: Elaborated by authors.

4.1 Cross cutting themes

Climate change and anthropogenic stressors

The impacts from climate change and anthropogenic pressures, such as urbanization and land use change, are common threads across the region and may impact multiple enabling conditions.

It is estimated that all Pacific Islands Countries (and Territories) will experience warming of at least 1.5 °C before 2050 and up to 3.5 °C by 2100 with an increase in frequency of extremely high temperatures and more intense and more frequent extreme rainfall events (Bell *et al.*, 2016). Impacts of, and response to, climate change will vary amongst Pacific Islands Countries (and Territories) making adaptation and mitigation responses more difficult. Aquaculture species and production systems will be vulnerable to specific climate change impacts, such as increased temperature (e.g. seaweeds, pearl, giant clam), ocean acidification (e.g. all organisms that form shell or bone), sea level rise (e.g. pond-based mariculture on coastal margins), and increased intensity of cyclones (e.g. all aquaculture facilities and infrastructure (Jimmy, Pickering, and, Smith 2021) which can affect input and production enabling conditions. However, some aquaculture systems may benefit from climate change, such as tilapia, where the predicted increases in temperature and rainfall may favor production species, for example at higher elevations in Papua New Guinea where animal proteins are limited (Bell *et al.*, 2016; Jimmy, Pickering, and Smith, 2021). Warming waters driven by climate change will create new production areas for seaweed in some sub-tropical regions, while having negative effects on reproduction, productivity, and quality in tropical regions where surface temperatures exceed optimal growth thresholds (Hurtado, Critchley, and Neish, 2017). For shellfish culture, climate change and ocean acidification are predicted to have the greatest impact on developing and least developed nations into the twenty-second century(Stewart-Sinclair *et al.*, 2020).

Other anthropogenic pressures, such as urbanization, pollution, and land use change, can impact aquaculture development, siting, and biosecurity. Excess nutrients from more intensive agriculture and wastewater discharge are increasingly affecting water quality and coastal areas in the Pacific Islands region (M. J. Devlin *et al.*, 2021) but published water quality studies are limited in number and scope (M. Devlin *et al.*, 2020) to inform regulatory decision-making. Aquaculture may be more accessible on land (e.g. in earthen ponds or in tanks), however, with limited area and growing competition for space, coordinated siting will be necessary for sustainable growth.

The Pacific Islands region will need adaptive strategies to address these challenges to facilitate prosperous and sustainable aquaculture development. Diversifying genetic stocks that can tolerate increased temperatures, as well as being more resistant to disease, are recognized as pathways to safeguard the seaweed industry but many lack access to such resources (FAO, 2018b).

Regulatory environment

In many Pacific Islands Countries (and Territories), a lack of legislation that clearly defines land tenure makes investment into commercial operations difficult, while a deficiency in production and market value data prevents accurate assessments of market value and potential profitability from domestic and export markets (PBF, 2018).

Few countries in the Pacific Islands region have set up clear objectives and actions for the growth of different aquaculture species. **Annex 2** lists the countries that have developed long-term strategies for unfed and fed aquaculture products with the intent of regulating and streamlining production in the future. It is notable that only the Cook Islands, Samoa, and Vanuatu developed a management plan entirely focused on the production of a single species (e.g. pearls in the Cook Islands and sea cucumbers in Samoa and Vanuatu) while other Pacific Islands Countries (and Territories) have objectives and actions for each species within their national fisheries or aquaculture development plans. The Cook Islands aquaculture development plan is out of date, however, it can be helpful to know which objectives were originally established (and are probably still applicable) for the different aquaculture species.

In Nauru, land ownership issues have inhibited viable aquaculture business development, in addition to a lack of in-country technical expertize and few resources for breeding, rearing, harvesting and marketing aquaculture products (NFMRA, 2018). Slow aquaculture growth in Palau has been attributed to the current institutional framework and a lack of human resources, licensing and leasing barriers, a lack of investments due to unclear tenure rights, and an overall absence of an agreed upon, time bound roadmap to support and enable aquaculture development (PBF, 2018). Pacific Islands Countries (and Territories) producing seaweed require government support to maintain and expand export-oriented markets to remain competitive with established seaweed hubs in Southeast Asia (e.g. Indonesia, Philippines, and others) (ACIAR, 2020). Given the already fragile supply chain in the Pacific, disturbances in production and/or sales from disasters, price fluctuations, or inconsistent supply, can be enough to disrupt communities producing seaweed (ACIAR, 2020).

Subsidies

Some aquaculture production in the Pacific Islands region has thrived, even without farm-level profitability. For example, giant clam culture in Fiji and Samoa is currently active but primarily for stock enhancement to supplement wild populations. Giant clam production in these countries is subsidized by the government and economic returns are not the main goal of cultivation. Local cultural values for giant clams may have more significance than initially understood when the practice was introduced as these programmes have continued without realizing economic expectations (Moorhead, 2018). Subsidies can help develop enabling conditions where they are absent.

Challenging logistics

Given the remoteness of many Pacific Islands Countries (and Territories) , reliance on imported materials, whether as food for direct consumption or a inputs for produced species, makes economies vulnerable to changes in supply and cost (Bell *et al.*, 2016), as experienced during the COVID-19 pandemic. This affects both input and output enabling conditions.

Disruptions from the COVID-19 pandemic have impacted markets and supply chains for most Pacific Island countries, including the aquaculture sector. Loss of tourist activity and decreased demand in export of "luxury" (e.g. pearls, sea cucumber, etc.) items has forced many to pivot towards domestic markets and shorter supply chains (Jimmy, Pickering, and Smith, 2021). However, aquaculture businesses and food security needs continue to struggle amidst ongoing changes and uncertainty (Jimmy and Pickering, 2021). Technical assistance and other services (e.g. aquatic risk assessments and testing, hands on training, biosecurity assistance, applying for grants, on-farm management and improvements, etc.) have also been hampered, including those by the Pacific Community (SPC), affecting Member Nations (Jimmy *et al.*, 2021; Jimmy and Pickering 2021).

Lack of familiarity with aquaculture

Although aquaculture in the Pacific Islands region has been operating for decades, uptake has been slow and is still seen as a relatively new practice for many countries where it has not been a traditional livelihood. For example, awareness of potential mariculture systems is relatively low in Papua New Guinea where coastal and island communities have not traditionally relied on aquaculture systems, but could be encouraged through capacity building of technical and animal husbandry practices (ACIAR, 2019a). A lack of familiarity with aquaculture can negatively affect access to a sufficient labour force and social license to operate.

Gender equity and social inclusion

Coastal resources in the Pacific Islands region have historically been managed under local customs, however, economies are increasingly under external pressures. Most Pacific Islands Countries (and Territories) now have some combination of customary and formal legal systems to protect indigenous cultures and individual rights, and while women have historically faced discriminatory challenges (e.g. certain restrictions on land ownership, limited governance participation, etc.), these practices are (slowly) being addressed by government programmes and gaining traction with legislative bodies (Graham and D'Andrea, 2021). Further, commitments by Pacific Islands Countries (and Territories) leaders to address gender equity and social inclusion, as well as tools that governments can use to plan and implement such commitments, has recently been developed as a practical guide to address discriminatory practices and policies (SPC, 2021a). Progress in the Pacific Islands region is being made to improve gender equity issues, but challenges remain to be fully addressed.

5. Regional stakeholder analysis

The aquaculture sector is often built around complex supply chains that include input providers, farmers, traders/middlemen, processers, and retailers that all have different incentives but must work in close coordination to produce, harvest, and deliver highly perishable products. These actors must operate under the regulatory boundaries and policies set out by governing bodies while often seeking growth through the support of investors, ranging from conventional financial institutions (e.g. banks) to loans from input suppliers or family lending. Research institutions, service providers, and extension agents provide resources and technical training that can improve production practices and help facilitate knowledge transfer. Aquaculture sector stakeholders under the four production categories in this report (**Figure 7**) have overlapping, but unique characteristics that may help facilitate growth or pose challenges to development in the Pacific Islands region.

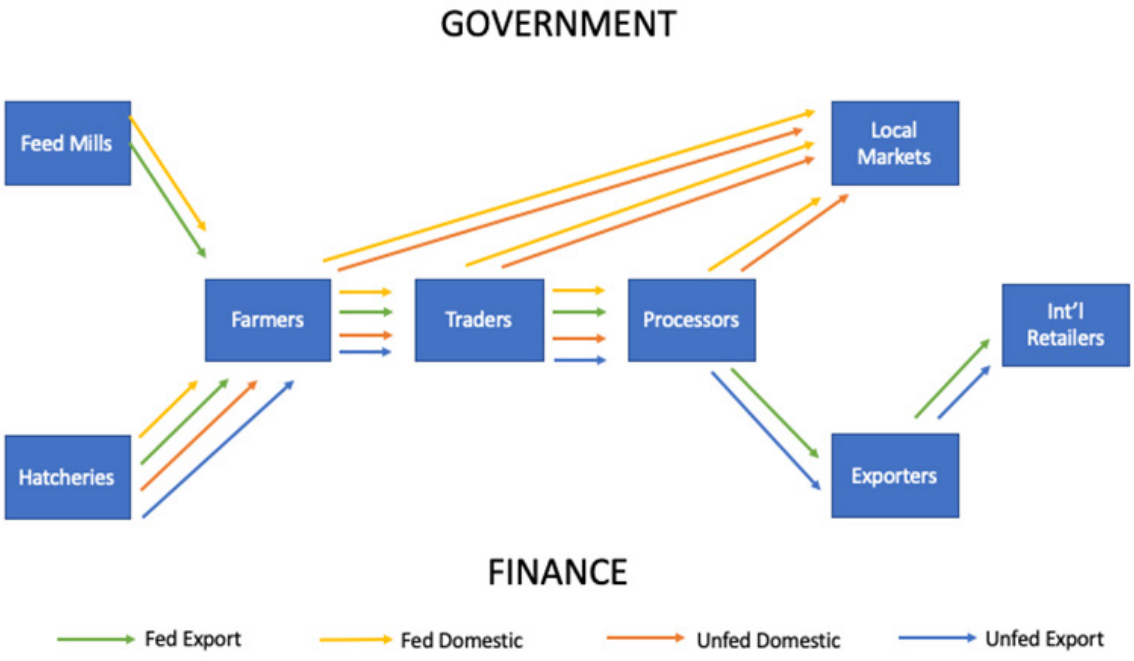


Figure 7. Comparison of the supply chain stakeholders under the four production categories of aquaculture

Source: Elaborated by authors.

Regional efforts to support aquaculture and provide resources include various government and non-government institutions. SPC is a scientific and technical organization established in 1947 to support the sustainable development of the Pacific Islands region. Within the organization, the Fisheries, Aquaculture and Marine Ecosystems (FAME) subdivision provides specific guidance and tools for informed decision-making of aquatic resources. SPC maintains online data portals, including the Pacific Data Hub (https://pacificdata.org/) and Pacific Ocean Portal (http://oceanportal.spc.int/portal/ocean.html) as well as a designated subdivision called the Statistics for Development Division (https://sdd.spc.int/), though there are limited resources or datasets specific to aquaculture.

A comprehensive dataset of aquaculture production across the Pacific Islands region was published in 2016 by SPC (Gillett, 2016), however a more accessible, real-time database of current aquaculture producers, commercial operations, input and resource providers, and research institutions would benefit the region to enable more collaborative sectorial growth. Most of the hatcheries provided in this list were established during the 1980s through aid-funded programmes and are government run (Amos *et al.*, 2014). Many of these facilities lack adequate resources to maintain or improve their facilities, often resulting in poor performance in juveniles with high mortalities and/or declining productivity that cannot meet demand or facilitate growth *(Amos et al.,* 2014).

6. Strategies for sustainable aquaculture growth in selected geographies

6.1 Production Categories for the Pacific Islands region

Given the existing landscape of present and absent enabling conditions in the Pacific Islands region, unfed production systems and fed species for domestic consumption have emerged to show promise for stimulating the development of the aquaculture sector. Although some species-specific challenges remain to be addressed, these production categories have advantages over fed species for export – such as requiring fewer material inputs and lower production costs.

The coastal and pelagic waters across much of the Pacific Islands region provides a productive growing environment for unfed species that do not require supplemental feed inputs – which can account for a

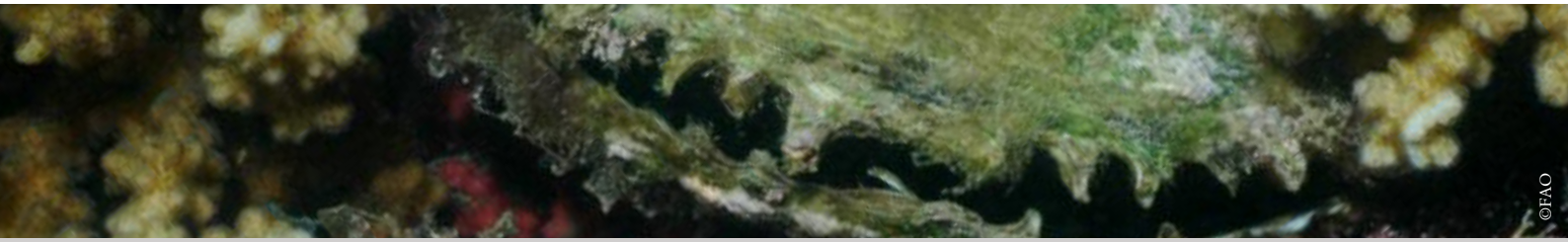
significant amount of a producer's operating costs and also adds to supply chain logistics. This low input and streamlined supply chain model has already proven economic viability in the Pacific Islands region (e.g. pearl culture in neighboring French Polynesia and New Caledonia brought in almost USD 60 million in revenue in 2020 [FAO, 2022b]). However, seaweeds destined for export need further processing and market access support to stimulate growth and meet the sector's potential.

Production volumes of fed aquaculture species for domestic consumption (e.g. tilapia) have been stagnant in recent years but, with additional support, could help to address food security concerns for the region in the face of declining wild capture fisheries. Ensuring that quality inputs are available, especially sustainably sourced and reliable feed ingredients, and providing access to improved management practices will be critical to further develop tilapia in the Pacific Islands region.

The logistical challenges associated with the remote islands of the Pacific Islands Countries (and Territories) make imported inputs and access to foreign markets difficult for fed export aquaculture. Globally traded aquaculture species that include carnivorous fish and crustaceans require quality (and costly) feeds, as well as refrigerated processing and packaging that meets international food safety requirements. Although the physical environment is conducive to support a breadth of export-oriented species, significant amounts of infrastructure, financial support, technical training, and supply chain mapping would be required to establish such an industry at this stage.

Three aquaculture production categories below have been identified within select Pacific Islands Countries (and Territories) that have proven to have met several enabling conditions and are on the pathway towards environmentally sustainable and economically prosperous aquaculture production. Although these three specific combinations of Pacific Island countries and aquaculture systems have been selected to show promise, there are many other species and geographies across the Pacific Islands region that would benefit from improved governance, financial support, and better access to inputs and markets.

6.2 Multicoloured *(Pinctada* spp.*)* and Mabé *(Pteria penguin)* pearls in Fiji — Production category: unfed domestic and export



Background

- Aquaculture has been identified as a priority sector by the Fijian Government.
- Fiji is a regional hub for training fisheries officers, technicians, and commercial operators.
- Pearl products are of high quality and occupy a different market niche than black pearls produced in neighboring Pacific islands.
- Private sector producers are active and profitable.
- Technical barriers for production are minimal and environmental impacts are low.
- Changing environmental conditions due to climate change will impact the industry.

Production category strengths

- Does not require feed;
- Available seed;
- Support as supplementary and/or alternative income for women;
- Conducive physical environment; and
- Low environmental impact.

What's missing

- Access to finance and financial tools for growth;
- Conducive regulatory environment;
- Utilization of best management practices and technology; and
- Access to diverse markets.

Recommendations

- Create a timebound Jurisdictional Approach improvement programme focused on developing pearl aquaculture that identifies key stakeholder and their roles through a co-designed workplan.
- Develop a scoping assessment to identify environmental and social challenges specific to the sector, followed by tailored actions to increase capacity and utilize improved management practices.
- Identify opportunities for impact investments across the supply chain and increase access to conventional finance (e.g. bank loans).
- Provide communication channels between domestic (e.g. tourism) and export (e.g. importers and retailers) markets. Streamline regulatory requirements to support pearl aquaculture development and exports

Potential benefits

- Revenue could be balanced by both domestic and international markets;
- Income generation would support livelihoods for women; and
- Bivalve aquaculture can provide biodiversity and water quality benefits.

6.3 Seaweeds and seagrapes *(Caulerpa lentillifera* and *C. racemose)* in Samoa — Production category: unfed domestic and export

Background

- An aquaculture development strategy has been developed by the government and there is staff capacity to address seaweeds and seagrapes.
- Highly trained and skillful officers and local producers with successful case studies of developing aquaculture systems.
- Previous seaweed trials have been successful to improve local livelihoods with a number of projects in progress to address farming techniques, post-harvest processing, and gender inclusion.
- The supply chain is considered simple and adequate for the current market while good transportation infrastructure (e.g. roads and ferries) can support growth.
- Changing environmental conditions due to climate change are impacting the industry.

Production category strengths

- Does not require feed;
- Available seed;
- Support as supplementary and/or alternative income for women;
- Conducive physical environment; and
- Low environmental impact.

What's missing

- Access to finance and financial tools for growth;
- Conduucive regulatory environment;
- Utilization of best management practices and technology; and
- Access to diverse markets.

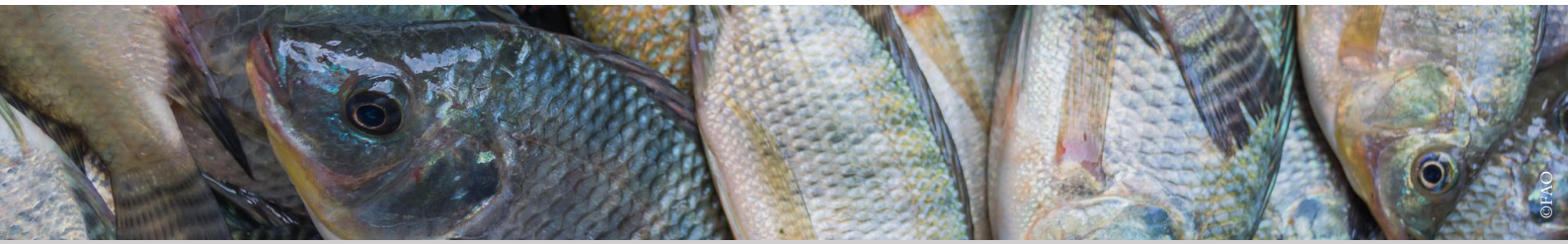
Recommendations

- Create a timebound jurisdictional approach improvement programme focused on developing seaweed and seagrape aquaculture that identifies key stakeholder and their roles through a co-designed workplan.
- Conduct a value/market-chain scoping assessment to identify environmental, social, and economic challenges specific to the sector, followed by tailored actions to increase capacity and utilize improved management practices across the supply chain.
- Involve more private sector actors in seagrape production and find opportunities for impact investments and conventional finance to support the sector.
- Increase domestic consumption of seagrapes (e.g. advertising nutritional benefits), identify export requirements (e.g. biosecurity and food safety), and create collaborations with restaurants and retailers in New Zealand and Australia. Idetnify market demand and appropraite packaging for doesmtic and export markets, including freight costs, to inform government and prive sector engagement.

Potential benefits

- Domestic consumption of seagrapes would provide essential nutrients and support food security.
- Seagrape production could be balanced by both domestic and export markets.
- Income generation would support livelihoods for women.
- Seaweed aquaculture can provide biodiversity and water quality benefits.

6.4 Tilapia in Solomon Islands — Production category: fed domestic



Background

- Aquaculture has been identified as a priority sector for the national government through their aquaculture strategy which includes clear objectives and goals, but implementation remains a challenge.
- Aquaculture is a well-developed recognized industry with several successful case studies.
- Both marine and terrestrial environments in the Solomon Islands are conducive for overall aquaculture development for freshwater, brackish, and marine systems.
- Tilapia can be produced in a range of conditions, generally require few technological inputs, and are profitable and in demand at local markets.
- Increased precipitation and warming temperatures due to climate change may benefit tilapia production.

Production category strengths

- Conducive physical environment;
- Social licence; and
- Access to processing and markets.

What's missing

- Access to feed;
- Access to finance and financial tools;
- Conducive regulatory environment; and
- Access to and utilization of best management practices and technology.

Recommendations

- Create a timebound Jurisdictional Approach improvement programme focused on developing tilapia aquaculture that identifies key stakeholder and their roles through a co-designed workplan.
- Develop a scoping assessment to identify environmental and social challenges specific to the sector, followed by tailored actions to increase capacity and utilize improved management practices.
- Identify opportunities for investments across the supply chain and increase access to conventional finance (e.g. bank loans).
- Develop collaboration between aquaculture and other industries that increase the availability of tilapia feed ingredients by supporting circular economy efforts (e.g. tuna processing wastes) and domestic producers (e.g. agricultural products) with less reliance on imported ingredients.
- Transition towards using genetically improved strains of Tilapia nilocticus (vs Tilapia mossambicus) for improved growth performance and ensure adequate distribution of seed each year to avoid inbreeding.

Potential benefits

- Consumption of tilapia would provide essential nutrients and support food security.
- Domestic markets would provide supplemental and/or alternative incomes.
- Local production of fish would be less susceptible to global supply and/or market shocks.

7. Recommendations and next steps

7.1 Recommendation to enhance unmet enabling conditions: a jurisdictional approach

Coordinated interventions will be necessary to address key input, production, and output challenges within the aquaculture sector to ensure that minimum viable enabling conditions are met. Case studies, research and development, and one-off grant-funded aquaculture projects have shown variable success in the Pacific Islands region over the last few decades, highlighting potential economic, social, or environmental benefits of specific activities but lacking the coordination to catalyse production across entire production regions or systems. Interventions beyond the farm-level that align government, financial institutions, and the supply chain could be leveraged to transition aquaculture production systems across Pacific Islands Countries (and Territories) through a jurisdictional approach. Jurisdictional approach improvement programmes have been implemented for terrestrial commodity supply chains, such as palm oil in Malaysia and Indonesia as well as soy in Brazil (Buchanan et al., 2019) but is an emerging strategy in the aquaculture sector which aims to align producers, governments, supply chains, and financial institutions within a geographic and/or political boundary (i.e. the "Jurisdiction") towards environmental sustainability, social responsibility, and economic development (Kittinger et al., 2021). An aquaculture jurisdictional approach intervention would require:

- scoping to identify key economic, environmental, and social challenges of the specific aquaculture system proposed for development;
- co-design by all participating stakeholders to ensure project success;
- implementation amongst those stakeholders against a timebound workplan and;
- indicators that show that identified economic, environmental, and social challenges have been mitigated or realized.

An aquaculture jurisdictional approach is designed to uplift whole production regions to meet sustainable enabling conditions, acknowledging that specific aquaculture species within production categories will be at various stages of development.

7.2 Next steps and priority needs

Mapping the current and unmet enabling conditions of aquaculture in the Pacific region brings the sector one step closer to achieving greater growth potential. Actions taken by sector stakeholders to address such unmet enabling conditions will determine the degree and speed to which that growth can be accomplished. Category-specific recommendations are detailed in Section 6, however, common gaps across these production examples highlight deficits where targeted interventions may help to improve the sector more broadly. Outlined below are four areas where sector actors can take action to advance aquaculture in the Pacific Islands region:

Improve access to finance and financial tools that encourage sustainable production

Who: Domestic and international financial institutions, foreign investors, regional and international donors, insurance companies, input suppliers that offer financing.

What: Access to finance, financial tools, and financial literacy are lacking across many facets of the aquaculture sector. More robust data collection, including for production, sales, and potential risk factors, would help to inform the types of financing and financial tools available to the aquaculture sector.

Create a more conducive regulatory environment

Who: National and provincial governments that are responsible for aquaculture development, international bilateral partners, regional organizations (e.g. SPC, FAO, WorldFish, ACIAR, etc.), regional and international non-governmental organization (NGOs).

What: Coordinated regional policies could be further developed to not only allow aquaculture but encourage sustainable development. For example, the Regional Aquaculture Strategy led by SPC, is currently being prepared as a mid-to-long-term regional aquaculture strategy informed by stakeholder input. However, the regulatory environment for aquaculture varies, it will be up to individual Pacific Islands Countries (and Territories) to adopt policies that encourage, support, or allow aquaculture.

Improve access to and utilization of best management practices and technology:

Who: National and regional aquaculture associations (e.g. producer groups, co-operatives, etc.), extension services and agents, regional organizations (e.g. SPC, FAO, WorldFish, ACIAR, etc.), research institutions, aquaculture technology companies, regional and international NGOs, private sector actors to utilize best management practices and technology.

What: A lack of technical capacity remains to be a challenge, ranging from biological understanding from an academic perspective to on-farm husbandry practices, to risk and disease mitigation practices, as well as environmental interactions and impacts. Interventions to improve management practices and technology in the Pacific Islands region has been ongoing for years, but could benefit from coordinated activities that include government, finance, and the supply chain.

Improve access to markets

Who: National and regional aquaculture associations (e.g. producer groups, co-operatives, etc.), commercial farms, logistics and shipping companies, processors, import/export companies, local and international wholesale and/or retail commodity businesses, local consumers of aquaculture products (e.g. restaurants, hotels, souvenir shops, local markets, etc.)

What: Ensuring that aquaculture products have access to markets at fair prices has often been inadequate to support expansion of the industry in the Pacific Islands region. Regional coordination could enhance export market leverage by improving resource efficiency and streamlining supply chains. Improved marketing for aquaculture products at a local level, including direct-to-consumer, restaurant and grocery, and tourism, would support food security efforts as well as contribute to livelihoods and income generation.

Annex 1

National policies and strategies aimed at growing the aquaculture sector

COUNTRY	STRATEGY or POLICY	MAIN OBJECTIVES/MILESTONES/PRIORITIES	PRIORITY SPECIES
COOK ISLANDS	Aquaculture Development Plan 2012-2016[1]	**Main goals:** 1. enhance populations of selected aquatic resources; 2. maintain food security; 3. diversify income-generating opportunities particularly in the Outer Islands; and 4. supplement capture fisheries in the Cook Islands.	▶ pearls ▶ clams ▶ trochus ▶ tilapia ▶ land crab ▶ malaysian prawn ▶ mantis shrimp ▶ sea grapes ▶ eel ▶ milkfish
	Marine Resources Act (2005)	It contains regulations for aquaculture management areas	
FIJI	Strategic Development Plan 2019-2029[2]	**2029 Goals:** 1. to have Fijian farmers producing and supplying 1 000 mt of Tilapia; 2. to have Fijian farmers producing and supplying 1 000 mt prawns; and 3. to have Fijian farmers sustainably producing and supplying to both local and export market two new species of cultured products. **Priorities** ▶ Develop 'fit for purpose' legislation. ▶ Develop tailored enabling programmes with NGO's. ▶ Develop robust biosecurity framework. ▶ Develop the National aquaculture plan. ▶ Create a sustainable market environment for two new cultured species. ▶ Develop joint venture initiatives with the private sector.	▶ tilapia ▶ shrimps ▶ prawns ▶ sandfish ▶ seaweed ▶ carp
	Fiji Aquaculture Bill (2016)[3]	**Principles:** 1. adopt measures to ensure the effective regulation of aquaculture; 2. ensure that such measures are based on the best scientific evidence available; 3. apply the precautionary approach; 4. assess the impacts of aquaculture, other human activities and environmental factors on fishery resources;	

1 SPC (2012). Cook Islands Aquaculture Development Plan: 2012–2016. Noumea, New Caledonia

2 Ministry of Fisheries (2019). Strategic Development Plan 2019-2029. Suva, Fiji

3 Government of Fiji (2016). Aquaculture Bill 2016. Bill no 9 of 2016, Suva, Fiji

COUNTRY	STRATEGY or POLICY	MAIN OBJECTIVES/MILESTONES/PRIORITIES	PRIORITY SPECIES
FIJI		5. adopt measures to minimize waste, pollution originating from aquaculture premises, and impacts on fisheries resources, in particular endangered species and promote the development and use of selective, environmentally safe and cost-effective gear and techniques; 6. protect biodiversity in the aquatic environment, especially habitats of particular significance for fishery resources; 7. collect and share, in a timely manner, complete and accurate data concerning aquaculture activities; and 8. ensure broad participation of Fijians in aquaculture.	▶ tilapia ▶ shrimps ▶ prawns ▶ sandfish ▶ seaweed ▶ carp
	Fiji National Fisheries Policy (2020)[4]	**Strategic policy responses to issues:** 1. Formulate and implement commodity specific aquaculture development plans to focus and guide activities for sustainable aquaculture development for species identified as high priority. Key species such as new strains of tilapia, shrimp, prawns, sandfish, seaweed, carp, and local species (coral reef fish and invertebrates). 2. Identify new production systems for the key focus commodities to improve survival on both hatchery and grow out. 3. Promote land use and land planning, including use of aquaculture park or zone concept. 4. Focus on species production that can reduce imports. 5. Support the development and improvement of specialized infrastructure and equipment to support quality feed and seed production. 6. Develop an aquaculture information management system. 7. Finalize and implement an enabling legislative framework for development and management of sustainable aquaculture that supports business investment opportunities while safeguarding the public interest in aquatic resources. 8. Increase collaborative research and development initiatives, including bilateral cooperation. 9. Promote public-private partnerships in collaborative projects to encourage private sector investment in aquaculture and reduce the risks of pioneer investment. 10. Facilitate an increase in availability of technical support services from the private and non-government sectors, including regional agencies and development partners. 11. Develop and implement aquaculture fisheries research strategy aiming to ensure advice is available to support investment decision making. 12. Establish the Aquaculture Advisory Council. 13. Promote active participation, engagement and involvement of women and youth in all aspects of the aquaculture industry.	

4 Ministry of Fisheries (2020). National Fisheries Policy. Suva, Fiji

COUNTRY	STRATEGY or POLICY	MAIN OBJECTIVES/MILESTONES/PRIORITIES	PRIORITY SPECIES
Federated States of Micronesia	Federated States of Micronesia Aquaculture Management and Development Plan 2019-2023[5]	**Main objectives:** 1. Improve coordination and awareness between national government and donors, state governments, private sector and civil society organizations. 2. Develop a strategy for aquaculture development, which will be incorporated into the overall fisheries policy for the Federated States of Micronesia National Government. 3. Improve the investment climate for aquaculture in the Federated States of Micronesia. NB This objective will need to be carried out in close collaboration with the states, who control investment and regulation of aquaculture within the 19 km limit. 4. Protect the biodiversity of the Federated States of Micronesia and the environment and traditional livelihoods practices from harmful disease. 5. Incorporate climate change considerations into national aquaculture activities. 6. Promote trade and investment in aquaculture in the Federated States of Micronesia states both internationally and domestically 7. Improve strategies for access to capital and funding for aquaculture in the Federated States of Micronesia. . 8. Increase human and infrastructure capacity for aquaculture in the Federated States of Micronesia . 9. Promote best management practices (BMPs) for aquaculture in the Federated States of Micronesia . 10. Improve knowledge of costs and benefits of aquaculture projects in the Federated States of Micronesia. 11. Enhance access to capital and funding for aquaculture through capacity building for banks and farmers. 12. Collect and disseminate aquaculture statistics for the Federated States of Micronesia.	▶ giant clams (Kosrae State, Pohnpei State, Yap State) ▶ trochus (all States) ▶ sponges (Chuuk State, Pohnpei State, Yap State) ▶ marine food fish (Kosrae State, Pohnpei State, Yap State) ▶ corals (Chuuk State, Kosrae State, Yap State) ▶ pearls (Chuuk State, Pohnpei State) ▶ sea cucumber (all States) ▶ seaweed (Pohnpei State)
KIRIBATI	Kiribati National Fisheries Policy (2013-2025)[6]	**Strategic action:** ▶ Review aquaculture activities and develop Aquaculture Development ▶ Strategy to maximize food security and livelihood benefits.	▶ milkfish ▶ pearls ▶ seaweeds ▶ seeding clams

5 Federated States of Micronesia National Government Department of Resources and Development (2019). Federated States of Micronesia Aquaculture Management and Development Plan. Fisheries Section with the assistance of the Pacific Community (SPC), Palikir, FMS.

6 Ministry of Fisheries and Marine Resources Development Government of Kiribati (2013). Kiribati National Fisheries Policy 2013-2015. Tarawa, Kiribati

COUNTRY	STRATEGY or POLICY	MAIN OBJECTIVES/MILESTONES/PRIORITIES	PRIORITY SPECIES
MARSHALL ISLANDS	The Republic of the Marshall Islands Strategic Plan 2019-2023[7]	**Sub-action under Strategic Goal 1:** ▶ Promote research and private investment into aquaculture to improve opportunities for Marshall Islands communities.	▶ giant clams ▶ black-lip pearl oyster
	Marshall Islands Aquaculture Regulations 2019	It defines authorities, planning, licensing, import and export methods, safety of products, and regulations for aquaculture development.	
NAURU	National aquaculture business development strategy (2019)[8]	**Main goal:** ▶ To encourage the development of aquaculture enterpries that assist in food security, reduces the reliance on imports and capture fisheries. **Main objectives** ▶ develop the growth of 2 main strategic aquaculture species: milkfish and giant clams; and ▶ development of a minimum of two and maximum of six pilot pond farms that will be used to demonstrate good farming practices, train future farmers, establish local growth and survival data, and evaluate the overall economics in a Nauruan setting.	▶ milkfish ▶ giant clams
	Coastal Fisheries and Aquaculture Act 2020[9]	**A national aquaculture plan shall:** 1. identify the types of aquaculture activities and their characteristics; 2. describe, as the case may be: ▶ the land tenure and characteristics including but not limited to soil, topography, and land use patterns in the area; ▶ the aquatic area and tenure, and the characteristics including but not limited to water type and usage; and 3. specify the objectives to be achieved by the aquaculture operations; 4. specify management and development measures to be applied, as appropriate; 5. consider the fishing interests of artisanal fishers; 6. include an environmental impact assessment report; 7. comply with the requirements of this Act and any other relevant written law; and 8. make provision in relation to any other matter necessary for sustainable use of aquaculture resources.	

7 Marshall Islands Marine Resources Authority (2019). The Republic of the Marshall Islands Strategic Plan 2019-2023. Majuro, Marshall Islands

8 Nauru Fisheries and Marine Resources Authority (2019). National aquaculture business development strategy. Yaren, Nauru

9 Government of Nauru (2020). Coastal Fisheries and Aquaculture Act 2020. No 12 of 2020, Yaren, Nauru

COUNTRY	STRATEGY or POLICY	MAIN OBJECTIVES/MILESTONES/PRIORITIES	PRIORITY SPECIES
PALAU	National aquaculture business development strategy (2019)[10]	A draft aquaculture strategy for Palau was delivered in July 2009 but it was never enacted. A strategic plan needs to be developed under the three following principles: 1. sustainability 2. vision 3. goal **Main goals:** ▶ Be directed towards replacing the fishing effort in reef fisheries for food security and supply the demand from the tourist market. ▶ Be driven by improvements in the use of existing and new locations, species, products and markets. ▶ Take place through an environmentally sustainable approach accounting for the need to preserve the values of special environmental conditions in Palau. **Main objectives** Develop the growth of three main strategic aquaculture species: milkfish, giant clams, and rabbitfish.	▶ milkfish ▶ giant clams ▶ rabbitfish
Papua New Guinea	Roadmap for coastal fisheries and marine aquaculture for Papua New Guinea: 2017–2026[11]	**Main objectives:** 1. Establish an enabling environment to fully implement effective policies, legislation, management frameworks, coordination and financing mechanisms. 2. Ensure suitable capacity development and access to information for capacity building, education and awareness-raising activities, and ensure the provision of information for the management and sustainable development of coastal resources and marine aquaculture by all stakeholders, with a particular emphasis on women and youth. 3. Manage coastal resources for sustainable development and maintain and restore coastal resources to secure long-term social and economic benefits for coastal and island communities. **Milestones (2023-2026)** ▶ 75% of coastal and island communities regularly receive awareness and information; ▶ 30% of coastal and island communities have accessed alternative livelihood support; and ▶ coastal fisheries management is operational and sea cucumber stocks are stabilized.	▶ gold-lip and black lip pearl ▶ sandfish (sea cucumber) ▶ ornamental fish, corals and clams ▶ finfish ▶ oysters

10 Palau Bureau of Fisheries (2019). National aquaculture business development strategy. Ngerulmud, Palau.

11 Government of Papua New Guinea (2017). A Roadmap for coastal fisheries and marine aquaculture for Papua New Guinea: 2017–2026. Port Moresby, Papua New Guinea

COUNTRY	STRATEGY or POLICY	MAIN OBJECTIVES/MILESTONES/PRIORITIES	PRIORITY SPECIES
SAMOA	Samoa Aquaculture Management and Development Plan 2013–2018[12]	**Main objectives:** 1. To promote better aquaculture management practices. 2. To improve marketability of aquaculture products in Samoa.. 3. To diversify the number of aquatic species that can be cultured in Samoa. 4. To improve quality and availability of lower-cost feeds for aquaculture. 5. To ensure access by farmers to the best possible genetic quality of seed stocks. 6. To promote private sector development. 7. To improve human resource capacities to manage and develop aquaculture. 8. To improve aquaculture networking.	▶ giant clams ▶ sea grapes (Caulerpa racemosa) ▶ tilapia ▶ mullet ▶ trochus ▶ malaysian freshwater prawn
	Fisheries Management Act 2016	It defines aquaculture operations outside village fisheries management areas, aquaculture farming management, and aquaculture operations within village fisheries management areas.	
SOLOMON ISLANDS	Solomon Islands national aquaculture management and development plan 2018–2023[13]	**Main objectives:** 1. To build and strengthen capacity for sustainable aquaculture development and management in Solomon Islands. 2. To promote good governance and best practice in sustainable aquaculture management and development. 3. To establish a conducive environment for aquaculture sector development and growth as an option for economic, livelihood and food security opportunities. 4. To promote and improve aquaculture collaboration, partnerships and networking. 5. To identify and establish sustainable financing and markets for aquaculture commodities.	▶ seaweed ▶ nile tilapia ▶ mozambique tilapia ▶ mud crab

12 SPC (2012). Samoa Aquaculture Management and Development Plan 2013–2018. Secretariat of the Pacific Community (SPC), Noumea, New Caledonia

13 Solomon Islands Ministry of Fisheries and Marine Resources (2018). Solomon Islands national aquaculture management and development plan 2018–2023. Honiara, Solomon Islands

COUNTRY	STRATEGY or POLICY	MAIN OBJECTIVES/MILESTONES/PRIORITIES	PRIORITY SPECIES
TONGA	Kingdom of Tonga national aquaculture management and development plan 2018-2022[14]	**Main objectives:** 1. Develop and improve market access to aquaculture products for both domestic and export markets. 2. Promote good governance and best practice for aquaculture management and development. 3. Raise awareness and understanding of the importance and potential of aquaculture in Tonga. 4. Improve input for aquaculture such as feeds, seeds, broodstock, equipment, skills and technology. 5. Promote and ensure that the aquaculture industry contributes to the economic development and social wellbeing of the people of Tonga. 6. Improve partnership, collaboration and networking. 7. Promote pathways to aquaculture commercialization.	▶ mabe pearl ▶ giant clams for food and aquarium trade ▶ mozuku ▶ mullet and milkfish (from wild seed) ▶ sea cucumber for sea ranching ▶ kappaphycus ▶ sea grapes ▶ tilapia
	Aquaculture Management Act (2003)	It defines responsibilities, authorities, protection of the environment principles, enforcement, and regulations for aquaculture development.	
VANUATU	Vanuatu National Roadmap for Coastal Fisheries: 2019–2030[15]	**Action 6.2 under Livelihood and wellbeing:** ▶ Promote innovation and development of appropriate aquaculture production in rural areas to support livelihoods and nutrition.	▶ marine shrimps ▶ giant clams ▶ tilapia ▶ freshwater prawns ▶ trochus ▶ green snail

Source: elaborated by the authors

14 SPC & Tonga Ministry of Fisheries (2018). Kingdom of Tonga national aquaculture management and development plan 2018-2022. Nuku'alofa, Tonga.

15 Vanuatu Fisheries Department & SPC (2019). Vanuatu National Roadmap for Coastal Fisheries: 2019–2030. Port Vila, Vanuatu.

Annex 2

Long-term objectives and activities for the growth of fed and unfed aquaculture products within Pacific countries

SPECIES	COUNTRY	PLAN	STRATEGIC PRIORITIES AND OUTCOMES
			UNFED
Sea cucumbers	**Samoa**	Samoa Sea Cucumber Fisheries Management and Development Plan (2015)[16]	▶ Promote the development of sustainable sea cucumber aquaculture for the benefit of Samoa and its people. ▶ Sea cucumber aquaculture licence: Applicable to nationals of Samoa who intend to culture/ranch and farm sea cucumber for export. This licence is not transferable and is valid for a period of 36 months (3 years) from the date of issue.
	Vanuatu	Vanuatu National Sea Cucumber Fishery Management Plan 2019–2024[17]	**Main actions:** ▶ Collect, from all licence holders, management fees that will go towards activities enhancing wild sea cucumber stocks. ▶ Undertake training in monitoring of sea cucumber aquaculture activities. ▶ Ensure that all sea cucumber aquaculture activities are in line with Vanuatu Government policies.
	Federated States of Micronesia	Federated States of Micronesia Aquaculture Management and Development Plan 2019-2023	**Chuuk state:** *In 3-5 years* ▶ Establish monitoring programme on growth and survival. ▶ Identify potential buyers and work to establish an equitable pricing strategy. ▶ Revisit management plan and enforcement of regulations. **Kosrae State:** *In 7-10 years* ▶ Maintain sea cucumber restocking efforts. ▶ Conduct review of project and amend where necessary. **Pohnpei State:** *In 3-5 years* ▶ Conduct community training on harvesting and post-harvest treatment. ▶ Provide assessment workshop at end of year 5. ▶ Assess and adjust OFA sea cucumber management plan. ▶ Continue technical assistance as necessary. **Yap State** *In 3-5 years* ▶ Restocking programme continues. ▶ Monitoring and enforcement continues. ▶ Sea cucumber fishery is well managed and providing sustainable income for communities.

16 SPC (2015). Samoa Sea Cucumber Fisheries Management and Development Plan. Noumea, New Caledonia

17 Vanuatu Fishery Department & SPC (2019). Vanuatu National Sea Cucumber Fishery Management Plan 2019–2024. Port Vila, Vanuatu.

SPECIES	COUNTRY	PLAN	STRATEGIC PRIORITIES AND OUTCOMES
UNFED (Cont.)			
	Solomon Islands	Solomon Islands National Aquaculture Management andDevelopment Plan 2018–2023	**Long-term activities (4-5 years)** ▶ Review management regulations that govern harvest and restocking activities for culture product. ▶ Expand restocking programme to include other provinces. ▶ Investigate market opportunities and value chains to increase export potential by working with private sector. ▶ Collaborate with regional and technical institutions such the SPC, WF and other relevant NGOs to provide support to improve technical skills in restocking and ranching. ▶ Encourage private sector investment for commercial-level production of sea cucumber seed and farming of sea cucumber. ▶ Investigate the viability of sea cucumber ranching as a management measure. ▶ Expand restocking programmes to include other provinces.
Pearls	**Cook Islands**	The Manihiki Pearl Farming Management Plan 2016-2026[18]	▶ Employ environmentally sound practices for pearl farming for the long-term future sustainability of the lagoon, both for those who live on the island of Manihiki and for future generations. ▶ Develop the pearl farming industry in harmony with traditional values and practices of Manihiki society. ▶ Enhance economic prosperity and encourage the full participation of all sectors of the Manihiki community in pearl farming for socioeconomic development. ▶ Establish a transparent and accountable system of lagoon management for pearl farming in Manihiki lagoon. ▶ Generate the best available information to assist with decision making on the management of the lagoon and pearl farming.
	Tonga	Kingdom of Tonga National Aquaculture Management and Development Plan 2018–2022	▶ Regulate the trading of pearl and assist with the traceability required for branding and certification through licensing.
Giant Clams	**Cook Islands**	Cook Islands Aquaculture Development Plan 2012-2016	▶ Build many more cages for nursery production. ▶ MMR to produce more spat for nurseries. ▶ Establish private public partnership under a clear MOU for spat production, nursery management, growout and harvesting by MMR in partnership with communities and private sector. ▶ Encourage labour for cage cleaning during grow-out. ▶ Training and capacity building for nursery and grow-out management. ▶ Review marketing arrangements and explore innovative marketing strategies. ▶ Investigate options for alternative and renewable energy sources to reduce costs of clam production.

18 Ministry of Marine Resources (2016). The Manihiki Pearl Farming Management Plan 2016-2026. Avarua, Cook Islands

SPECIES	COUNTRY	PLAN	STRATEGIC PRIORITIES AND OUTCOMES
UNFED (Cont.)			
	Federated States of Micronesia	Federated States of Micronesia Aquaculture Management and Development Plan 2019-2023	**Kosrae State:** *In 7-10 years* ▶ More farms will come on line as demand grows. ▶ Research and development into more coral species to grow. **Pohnpei State:** *In 3-5 years* ▶ Continue monitoring growth and survival of restocking programmes. ▶ Continue spawning and stock enhancement activities. ▶ Re-evaluate the management plan. ▶ Community farming becomes sustainable. **Yap State** *In 3-5 years* ▶ Conduct an outer island awareness programme to prevent over harvesting. ▶ Continue clam production and extension programme with farmers. ▶ Initiate ornamental clam farming with communities in conjunction with coral farming.
Seaweeds	**Cook Islands**	Cook Islands Aquaculture Development Plan 2012-2016	**Sea grapes strategy:** ▶ Within 5 years, a small industry supplying the local market with 200–300 kg of sea grapes per month.
	Federated States of Micronesia	Federated States of Micronesia Aquaculture Management and Development Plan 2019-2023	**Pohnpei State:** *In 3-5 years* ▶ Continue farm expansion. ▶ Undertake project evaluation and monitoring.
	Solomon Islands	Solomon Islands National Aquaculture Management and Development Plan 2018–2023	**Long term actions (4-5 years):** ▶ Increase production to 5 000 tonnes. ▶ Facilitate training on downstream processing to private sector and farmers. ▶ Increase production by 50% and access to all provinces ▶ Introduce an improved strand. ▶ Facilitate and encourage private producers and private sector into value-adding. ▶ Investigate and encourage private sector participation for downstream processing of the product and create new market opportunities. ▶ Strengthen skills for farm management and production, basic business and marketing.

SPECIES	COUNTRY	PLAN	STRATEGIC PRIORITIES AND OUTCOMES
UNFED (Cont.)			
	Tonga	Kingdom of Tonga National Aquaculture Management and Development Plan 2018–2022	▶ Trial farming of Kappaphycus farming seaweed. ▶ Train farmer in post – harvesting processing of seaweed.
Corals	**Federated States of Micronesia**	Federated States of Micronesia Aquaculture Management and Development Plan 2019-2023	**Chuuk State:** *In 3-5 years* ▶ Begin monitoring programme in replanted areas. ▶ Initiate private sector partner buying and exporting of corals. ▶ Raise awareness and investigate ecotourism projects. ▶ Identify some kind of branding for Chuuk corals. ▶ Replicate restocking projects and expand export farms to other sites. **Kosrae State:** *In 7-10 years* ▶ More farms will come on line as demand grows. ▶ Research and development into more coral species to grow. **Yap State:** *In 3-5 years* ▶ Export becomes stable and sustainable. ▶ Communities are making income from coral farming activities. ▶ Coral farming activities are linked to conservation, inshore fisheries and climate change activities.
	Solomon Islands	Solomon Islands National Aquaculture Management and Development Plan 2018–2023	**Long-terms activities (4-5 years):** ▶ Increase number of farmers, production and diversify of species ▶ Develop land and sea policy regulation. ▶ Strengthen, encourage and promote private sector involvement and investment in the ornamental trade. ▶ Specialize in three of the most resilient and valuable corals. ▶ Focus development on viable and operational locations. ▶ Explore direct marketing options.

SPECIES	COUNTRY	PLAN	STRATEGIC PRIORITIES AND OUTCOMES
UNFED (Cont.)			
Sponges	**Federated States of Micronesia**	Federated States of Micronesia Aquaculture Management andDevelopment Plan 2019-2023	**Chuuk State:** *In 3-5 years* ▶ Test marketing of sponges for export conducted. ▶ Sponge management plan reassessed. ▶ Farms are operating sustainably. ▶ Training of trainers for sponge farming and replication where possible. **Pohnpei State:** *In 3-5 years* ▶ Expand farms to new communities. ▶ Test outer island farming. ▶ Increase marketing efforts. ▶ Link activities to conservation, coastal fisheries and climate change programmes. **Yap State:** *In 3-5 years* ▶ Expand farms to new communities. ▶ Test outer island farming. ▶ Include farm tours in ecotours. ▶ Increase marketing efforts. ▶ Link activities to conservation, coastal fisheries and climate change program.
	Solomon Islands	Solomon Islands National Aquaculture Management andDevelopment Plan 2018–2023	Same activities as corals above.
FED			
Tilapias	**Cook Islands**	Cook Islands Aquaculture Development Plan 2012-2016	**Strategy within 5 years:** ▶ Increase in fish availability and employment opportunities through viable tilapia aquaculture enterprises.
	Fiji	Strategic Development Plan 2019 - 2029	▶ By 2029, to have Fijian farmers producing and supplying 1 000 Mt of Tilapia.
	Solomon Islands	Solomon Islands National Aquaculture Management and Development Plan 2018–2023	**Long-term activities (4-5 years)** ▶ Establish farmer communication network. ▶ Promote access to markets and investment. ▶ Utilize farmed fish as protein source for feed production.
Milkfish	**Cook Islands**	Cook Islands Aquaculture Development Plan 2012-2016	**Strategy within 5 years:** ▶ Regular flow of farmed milkfish into local fish markets.
	Federated States of Micronesia	Federated States of Micronesia Aquaculture Management and Development Plan 2019-2023	**Kosrae State:** *In 7-10 years* ▶ Farms are operating sustainably. ▶ Consideration is given to establishing larger, commercial-scale milkfish farming at this point.

SPECIES	COUNTRY	PLAN	STRATEGIC PRIORITIES AND OUTCOMES
FED (Cont.)			
	Solomon Islands	Solomon Islands National Aquaculture Management and Development Plan 2018–2023	**Long-term activities (4-5 years)** ▶ Explore opportunities to attract partnerships with commercial investors ▶ Undertake market surveys and market value chain assessments, marketing and investment promotion. ▶ Facilitate the establishment and operations of at least one semicommercial farm. ▶ Investigate value-adding options to improve the value chain on small-scale level.
Trochus	**Cook Islands**	Cook Islands Aquaculture Development Plan 2012-2016	**Strategy within 5 years:** ▶ Through either re-stocking, or improved harvest management, or both (as appropriate) achieve a 25% increase in trochus landings.
	Federated States of Micronesia	Federated States of Micronesia Aquaculture Management and Development Plan 2019-2023	**Pohnpei State:** *In 3-5 years* ▶ Continue monitoring growth and survival of restocked trochus. ▶ Continue spawning and stock enhancement activities. ▶ Re-evaluate the management plan. ▶ Conduct periodic harvests based on resource surveys. **Yap State:** *In 3-5 years* ▶ Hatchery is continuously operational. ▶ Enforcement programme is continuously operational. ▶ Trochus harvests are larger and restocking continues annually bringing sustainable income to the communities. ▶ A management plan for trochus is developed. **Chuuk State:** *In 3-5 years* ▶ Continuous production of trochus seed and restocking of seed in the sanctuaries. ▶ Harvest trochus for export market. ▶ Reassess the trochus management plan. **Kosrae State:** *In 7-10 years* ▶ Trochus harvests are larger and restocking continues annually.
Shrimps	**Cook Islands**	Cook Islands Aquaculture Development Plan 2012-2016	***Giant Malaysian freshwater prawn*** **Strategy within 5 years:** ▶ Viable small-pond operators in public private partnership with government to produce prawns for local market. ▶ Mantis shrimp ▶ Strategy within 5 years: ▶ Several small businesses in operation capturing and fattening mantis shrimp for local sale and export.
	Fiji	Strategic Development Plan 2019 – 2029	▶ By 2029, to have Fijian farmers producing and supplying 1 000 Mt shrimps.

SPECIES	COUNTRY	PLAN	STRATEGIC PRIORITIES AND OUTCOMES
FED (Cont.)			
	Solomon Islands	Solomon Islands National Aquaculture Management and Development Plan 2018–2023	***Freshwater prawn (Macrobrachium rosenbergii) and Shrimp (Penaeus monodon)*** **Long-term activities (4-5 years):** ▶ Privatize the prawn industry. ▶ Invite private investors to explore opportunities to invest in the country. ▶ Conduct market analysis, marketing and investment promotion.

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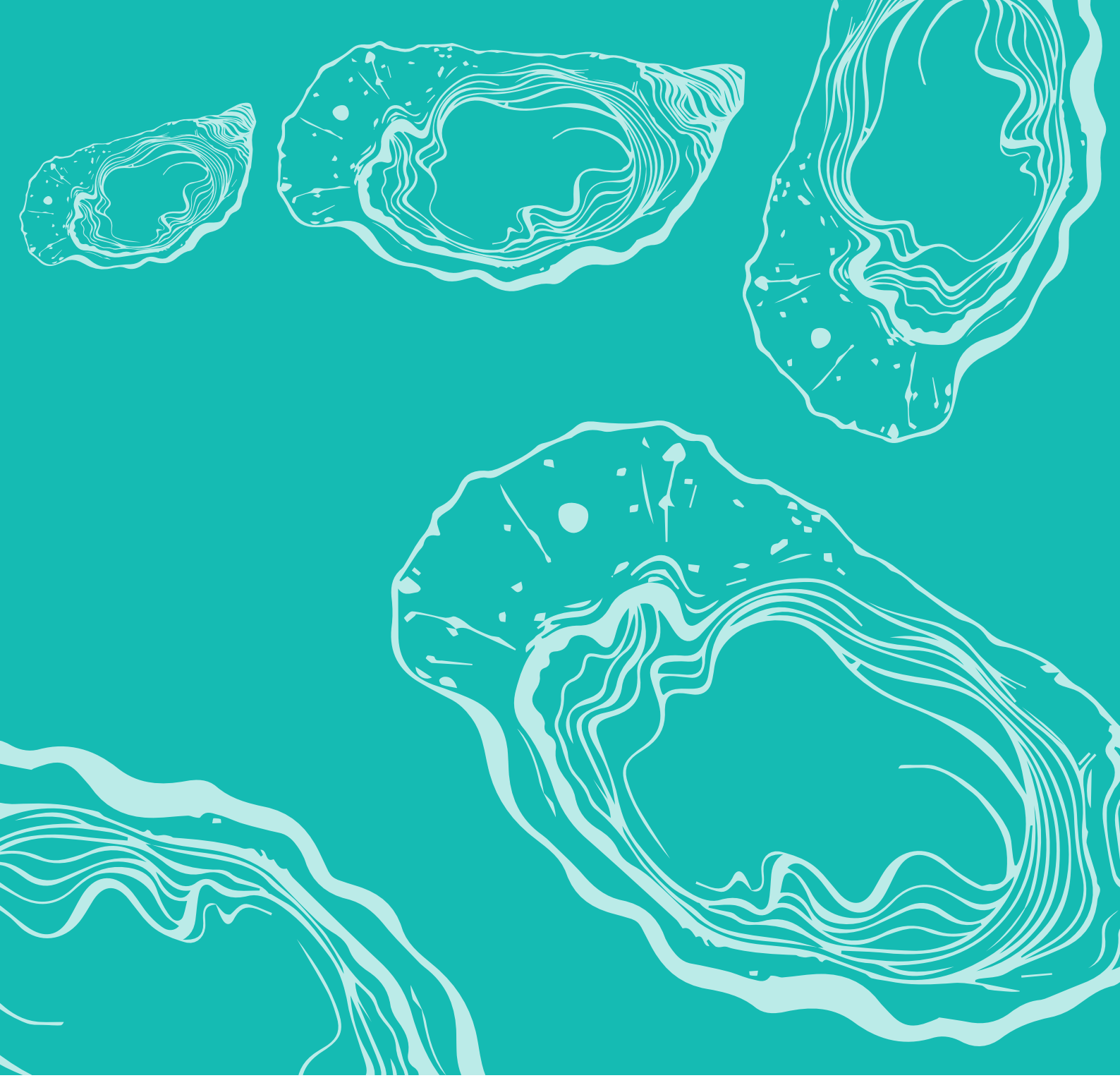

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