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Foundation analysis to identify innovation pathways to enhance
participation by the Pacific community and value retention in the
region

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ACRONYMS

ACIAR	Australian Centre for International Agricultural Research	PNG	Papua New Guinea
CAGR	Compound Annual Growth Rate	PPP	Public Private Partnership
CSO	Civil Society Organisations	PTI	Pacific Trade Invest
DHERST	Department of Higher Education, Research, Science and Technology	SIDS	Small Island Developing States
DWFN	Distant Water Fishing Nations	SPC	The Pacific Community
EEZ	Exclusive Economic Zone	ULT	Ultra-low temperature
ENSO	El Niño Southern Oscillation	US	United States
EQAP	Educational Quality and Assessment Programme	VDS	Vessel Day Scheme
EU	European Union	WCPO	Western and Central Pacific Ocean
EVI	Economic and Environmental Vulnerability Index		
FFA	Pacific Islands Forum Fisheries Agency		
FSM	Federated States of Micronesia		
GDP	Gross Domestic Product		
GMP	Good Manufacturing Process		
HACCP	Hazard analysis and critical control points		
IIF	Invest In Farming		
LDC	Least Developed Countries		
MPA	Marine Protected Area		
MSC	Marine Stewardship Council		
NCD	Non-communicable disease		
PARDI	Pacific Agribusiness Research in Development Initiative		
PHAMA Plus	Pacific Horticultural and Agricultural Market Access Plus		
PEUMP	Pacific-European Union Marine Partnership Programme		
PIC	Pacific Island country		
PIFR	Pacific Island Food Revolution		
PNA	Parties to the Nauru Agreement		

01

INTRODUCTION

- > Executive summary
- > Approach

Executive summary

Tuna is a key driver of the Pacific region's economic growth and there is already coordinated efforts underway between Pacific Island countries to maximise returns while sustainably managing tuna stocks. However, these efforts will need to be accelerated to counteract factors such as climate change, an increasingly complex regulatory environment and emigration of the working-age Pacific Island population. At the annual Pacific Island Forum Fisheries Agency (FFA) officials meeting in May 2021 (FFC118), a mandate was given for a landscape analysis of the Pacific tuna sector to be completed. The focus of the analysis was to consider long-term opportunities and constraints, focusing on feasibility and commercialisation of a short list of opportunities. The Australian Centre of International Agricultural Research (ACIAR) has jointly funded this project with FFA on a 50/50 basis.

GLOBAL TUNA SECTOR

Fish is expected to become an increasingly popular source of animal protein over the next decade, driven primarily by its lower carbon footprint compared to other sources of animal protein and a growing middle class who are health conscious and time poor. Tuna is one of the world's highest value fish in capture fisheries production, prized for its nutritional content and versatility in terms of end use across biomedical, food, feed and industrial sectors. Tuna is suitable for the significant proportion of the population who do not eat pork, providing an alternative source of protein.

¹ Poseidon Aquatic Resource Management (2020)

² imarc (2021)

³ United Nations Economic and Social Commission for Asia and the Pacific (2020)

⁴ World Bank (2021). FFA member countries only given the scope of this report. No data available for Cook Islands, Nauru, Niue, Tokelau and Tuvalu.

Growth in global tuna landings has steadily increased at a compound annual growth rate (CAGR) of 1.97 per cent over the period 2012 to 2018¹, with Pacific flagged states experiencing the highest growth rate in landings during this period, i.e., where a vessel is flagged/licenced/registered.

The value of the global tuna market for food products was US\$42.2 billion in 2022 and is projected to reach US\$50.2 billion in 2028². Canned tuna is by far the dominant shelf-stable product while also offering the greatest opportunity for value addition based on dock value of tuna compared to the final consumed end value of tuna product.

PACIFIC ECONOMIC AND SOCIOECONOMIC LANDSCAPE

Pacific Island countries (PICs) are some of the most economically and environmentally vulnerable countries in the world. Natural disasters have resulted in estimated average economic losses to the region of US\$1.075 billion per year – equivalent to nearly 5 per cent of combined Gross Domestic Product (GDP) for Pacific small island developing states³. The region's business environment has also progressively deteriorated with Papua New Guinea the only country to improve its ease of doing business score since 2014⁴.

Health, education and standards of living have improved in the past two decades across the Pacific region. However, urbanisation and the increased availability of cheap, processed foods through imports has contributed to staggering rates of non-communicable diseases, a key cause of death between the ages of 30 and 70. Furthermore, the Pacific is experiencing 'brain drain' due to more attractive work opportunities outside the region.

PACIFIC TUNA SECTOR

Tuna is a crucial resource for PICs and is an important part of the cultural heritage of the region. For some PICs, the tuna resources within their exclusive economic zones (EEZ) represent their only significant renewable resource.

**US\$479
million**

Contribution to Pacific government revenue from tuna resource license and access fees in 2021

FFA (2022a)

Tuna fisheries in the Western and Central Pacific Ocean (WCPO) have contributed approximately 53 to 58 per cent of global tuna catch over the past decade for albacore, bigeye, skipjack and yellowfin tuna¹. Purse seine catch volumes within the WCPO have steadily increased over the past few decades while conversely, longline catch volumes have decreased.

The Pacific tuna sector is export driven, with most processed exports comprised of intermediate products that are destined overseas for processing into final product. Key markets are Thailand, the European Union (EU), Japan and the United States (US). Most processing within the Pacific region occurs in Papua New Guinea (PNG), Solomon Islands, Fiji, Federated States of Micronesia (FSM) and American Samoa. Notably, Fiji's onshore processing volumes significantly exceed catch volumes in national waters.

Increasing pressure to ensure sustainable management of fisheries is creating greater tension between two somewhat conflicting definitions of 'sustainable stocks' – biologically sustainable versus economically sustainable for businesses operating in the sector.

¹ Western Pacific Regional Fishery Management Council (2023)

² IUCN (2020)

This is evident in the expansion of marine protected areas (MPA), despite recent studies finding that large-scale MPAs have limited conservation benefits for Pacific skipjack and bigeye tuna¹. For example, Fiji has committed to expanding its MPA to 30 per cent of its EEZ², resulting in many Fiji harvesters concerned about their future viability.

VALUE CHAIN OVERVIEW

The following key barriers and critical success factors were identified in the Pacific tuna value chain with respect to PIC businesses:

Key barriers

- Businesses are typically concentrated on a single value chain segment/function.
- Constrained by high costs of entry, high operating costs and challenges with achieving scale.
- Lack of infrastructure, particularly port facilities.
- High shipping/air cargo costs; infrequent and indirect routes to markets; lack of cold chain.
- Challenges with securing skilled employees, as well as cultural constraints of workers not used to the demands of modern work (e.g., regular working hours).

Critical success factors

- Vertical integration – To improve the flow of information, certainty of supply/offtake and manage other risks.
- Diversification – Distant water fishing nation/foreign companies are generally part of heavily diversified conglomerates.
- Scale – The Pacific's high-cost operating environment, particularly for logistics, power and water, means that scale is vital to operating profitably.

VALUE CHAIN SEGMENTS

Harvesting

The harvesting value chain segment has the highest risk profile with significant costs involved in purchasing, repairing and maintaining vessels, and a limited resale market. Subsidies are a key issue, distorting the market by allowing distant water fishing nations (DWFN) harvesting from the WCPO to operate below break-even point.

Localisation of the harvester workforce is a challenge with senior positions generally held by expatriates. Recruiting and retaining deck crew is becoming increasingly challenging, faced with competition from opportunities with better working conditions (e.g., other types of vessels such as cargo/container vessels and labour mobility schemes in Australia), as well as a lack of career paths. There is also limited and/or inconsistent fishing-specific training available from local training institutions.

Processing

Processing volumes in the Pacific have increased but the vast majority of processing is primary only, with secondary processing occurring outside of the region. Securing a steady supply of tuna is a key factor impacting throughput and therefore the profitability of processing operations, with many processors operating below capacity.

63 per cent of the Pacific tuna workforce is employed in the processing and ancillary segment¹, with women estimated at 70 per cent of the processing workforce².

¹ Pacific Island Forum Fisheries Agency (2022d)

² Barclay et al. (2021)

End markets

The Pacific region's key export markets are Thailand, Philippines, EU, US and Japan. Exports to Thailand and Philippines are mostly whole round tuna, while cooked loins are primarily exported to the EU, US and Thailand. The regulatory environment is becoming progressively complex and stringent, making it increasingly difficult for Pacific exports to compete in the global market.

Regional consumption of tuna varies from country to country, although an overall theme is that consumers are driven primarily by price.

Services

Key services to the Pacific tuna sector are:

- Transport – Air freight and sea. The cost and frequency of transport is a key factor impacting the cost structure of the Pacific tuna sector.
- Finance – Limited finance options within the region. DWFN/foreign companies rely on non-bank financial support, such as a from a parent company or majority shareholder.
- Training – Limited competency-based training for deck crew available from local institutions, resulting in a high reliance on crew from overseas (e.g., Philippines, Indonesia).
- Infrastructure and associated services – Limited infrastructure, facilities and expertise in the Pacific region. Parts are expensive given that they need to be imported in.

Crewing can also be considered a service but has been captured under 'harvester workforce' in this report.

INCLUSIVE INNOVATION PATHWAY OPPORTUNITIES

A key finding from this project is that businesses need to be vertically integrated, diversified and operating at scale in order to be competitive, given the high-cost operating environment in the Pacific – attributes that are virtually impossible for PIC businesses to achieve. Yet these challenges are not new – they have beleaguered the Pacific tuna sector for decades.

The aim of this project was to use a different lens when tackling the challenge of improving value retention from Pacific tuna resources. Given the Pacific's inherent constraints, the approach was to be **pragmatic** regarding the product/service being considered but **innovative** with respect to how it could be delivered.

Innovation requires both creativity and strategic thinking, but **timing** is often just as important as the idea itself. The opportunities shortlisted in this report consider short-term benefits while also looking towards the future, addressing foundational factors that need to be addressed now to strengthen the sector's long-term viability.

The five shortlisted opportunities fall into two categories – products and enablers. An additional section called 'Looking to the Horizon' considers early-stage innovations that may deliver benefits to the Pacific tuna sector over the medium- to long-term.



PRODUCTS

OPPORTUNITY 1: Health and wellness inputs

Creating intermediate products for the health and wellness industry. The next step for the Pacific region is producing hydrolysed protein powder from valorised tuna processing waste. This is a valuable input for food manufacturing and the nutraceutical industry, with modest equipment and skill requirements.

OPPORTUNITY 2: Fish meal, aqua, animal feed

Fish meal, aqua and animal feed production to support the Pacific local food system. The next step for the Pacific is valorising tuna processing waste into high-quality fish meal and optimising the production process. This involves low equipment and skill requirements and is a critical input for aquaculture development in the Pacific region, supporting food security.

ENABLERS

OPPORTUNITY 3: Cold chain development

One of the key constraints to growth of the Pacific tuna sector and tuna product innovation is cold chain logistics and infrastructure. For tuna, the next step is to determine the minimum viable production volumes for Opportunities 1 and 2 and associated cold chain requirements. However, a broader assessment of cold chain development opportunities across the Pacific is recommended, recognising that PNG's current state of cold chain development is more advanced than most other PICs.

OPPORTUNITY 4: Attracting and retaining local talent

To secure a pipeline of Pacific Islander talent as the sector becomes increasingly sophisticated (see 'Product' opportunities). The next step is raising the awareness of career opportunities in the tuna sector and future-proofing the Pacific fisheries training network.

OPPORTUNITY 5: Collective approach for small businesses

To achieve the critical success factors of integration, diversification and scale. The next step for the Pacific is to explore opportunities for taking a cooperative approach (e.g., vessel food provisioning) and sharing resources (online second-hand equipment market), as well as development of a Pacific food innovation hub.

LOOKING TO THE HORIZON

POSSIBILITY 1:

Community owned infrastructure

Co-financing infrastructure through models such as a cooperative.

POSSIBILITY 2:

Output financing innovations

Assessing financing innovations in other sectors/parts of the world, which could be adapted for the Pacific tuna sector.

Approach

PROJECT AIM

To identify potential **innovation pathways** and assess the **commercial feasibility** for improving returns (defined as sustainable resource management, maximum catch utilisation and increased retention of value) to the PIC tuna sector and PIC economies more broadly, particularly small fishers, small to medium-sized fishing businesses and their communities.

OBJECTIVES

1. Characterise Pacific-origin tuna value chains including positioning in the global market, unique attributes, and current and forecast issues and opportunities, as well as identifying and mapping key chain members and stakeholders.
2. Identify and characterise inclusive Innovation Pathway opportunities, including those that have been attempted before (both successful and unsuccessful) and opportunities that have not been investigated previously.
3. Analyse previously attempted inclusive Innovation Pathway opportunities to identify key barriers to success and critical success factors.
4. Understand the impact of key barriers and critical success factors identified in Objective 3 on the list of inclusive Innovation Pathway opportunities developed for Objective 2.
5. Research ways to address the top barriers identified that are impacting on development of inclusive Innovation Pathway opportunities in the Pacific tuna sector and develop opportunity prospectuses for addressing these barriers.

METHODOLOGY

The focus of this project was PNG, Fiji and the Solomon Islands as key case study countries based on comparative tuna sector importance, prioritising onshore processing volumes and the number of people employed by the sector (refer [Table 2](#)). Input has also been sought from other countries on a case-by-case basis, such as from value chain members in Samoa and Tonga.

The approach taken was as follows:

- Key informant interviews conducted with 19 Pacific tuna value chain members, as well as 16 other organisations adjacent to the value chain/sector (e.g., industry associations, researchers, fisheries consultants).
- Literature review carried out to understand the spectrum of primary and end uses of tuna parts.
- Outputs from the key informant interviews and literature review were used to develop the value chain analysis.
- A long list of opportunities was developed drawing from the work outlined above, spanning food, feed, biomedical and industrial uses, as well as enablers.
- These opportunities were shortlisted using a [set of criteria](#) and further analysis undertaken, focusing on commercial feasibility, viability within the region and customer desirability.

Please refer to [Appendix 2](#) for a summary of the project's alignment with the Regional Roadmap for Sustainable Pacific Fisheries and ACIAR's strategic objectives and Pacific priorities.

DATA NOTES

- All currency figures expressed in this report are in US dollars.
- FFA data sets include FFA members only (see list below).
- Key informant interviews were carried out over the period July 2022 to March 2023, during which COVID was still impacting local economies to varying degrees and therefore influenced key informant responses.
- Where appropriate, five-year data averages have been used to smooth out the effects of COVID.
- Please refer to [Appendix 3](#) for additional data notes.

FFA members (excluding Australia and New Zealand)

Cook Islands	Papua New Guinea
Federated States of Micronesia	Samoa
Fiji	Solomon Islands
Kiribati	Tokelau
Marshall Islands	Tonga
Nauru	Tuvalu
Niue	Vanuatu
Palau	

02

LANDSCAPE ANALYSIS

- > Global tuna sector**
- > Pacific economic and socioeconomic landscape**
- > Pacific tuna sector**

Global tuna sector

Fish is expected to become an increasingly popular source of animal protein over the next decade¹, driven primarily by its lower carbon footprint compared to other sources of animal protein and a growing middle class who are health conscious and time poor. As has been the case over the last decade, Asia is forecast to experience the greatest growth in consumption per capita (refer Figure 1).

Aquaculture is expected to be the primary means of meeting increased demand given pressures to maintain sustainable stocks of wild-caught fish, of which tuna is the world's most consumed².

Virtually all stocks of oceanic wild-caught fish are being fished at (and sometimes beyond) maximum sustainable levels. As such, key

ways of improving value returned in capture fish production is through value preservation/addition, waste reduction and cost efficiencies throughout the value chain.

In the case of tuna, the harvesting segment has primarily been focused on value preservation and cost efficiencies through the increased use of lower temperature freezers (i.e., less than -40°C), satellites, vessel upgrades and other technologies to improve the energy efficiency of vessels.

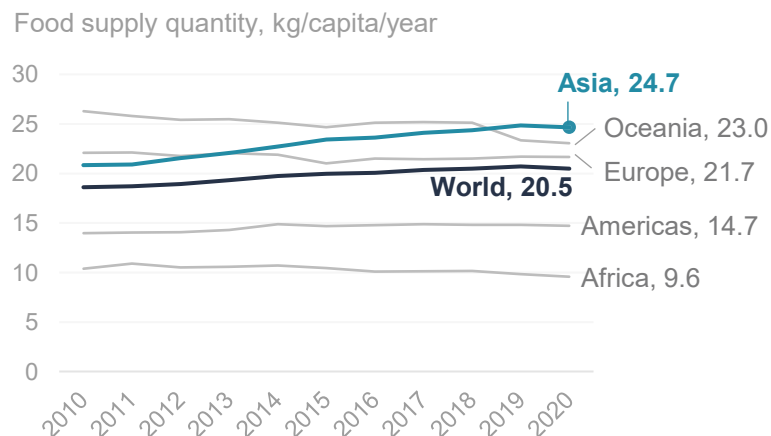
Tuna's versatility provides significant scope for product innovation across food, feed, industrial and biomedical end uses, creating a wide range of opportunities in processing. For example, canned tuna with improved nutritional profiles and alternative packaging types such as pouches target the growing segment of consumers who prioritise healthy diets and convenience. Other innovations include the use of purse seine-caught tuna as a substitute for products traditionally made from longline-caught tuna to increase profit margin. Tuna is suitable for the significant proportion of the population who do not eat pork, providing an alternative source of protein.

Closed-cycle aquaculture of tuna is in its nascent stage, yet growth in production for other aquatic species can still benefit the tuna sector with global aquaculture production by volume exceeding capture fish production since 2015². Feed is the primary production cost in aquaculture and one of the key constraints to growth in production, and tuna waste can be used as a key ingredient in feed.

Other early-stage innovations include tuna leather, which takes advantage of the highly durability of tuna skin given its criss-cross structure, and biodegradable films made from fish gelatin³.

FIGURE 1

Asia has driven per capita growth in apparent consumption of fish over the period 2010-20



Analysis from FAOSTAT data

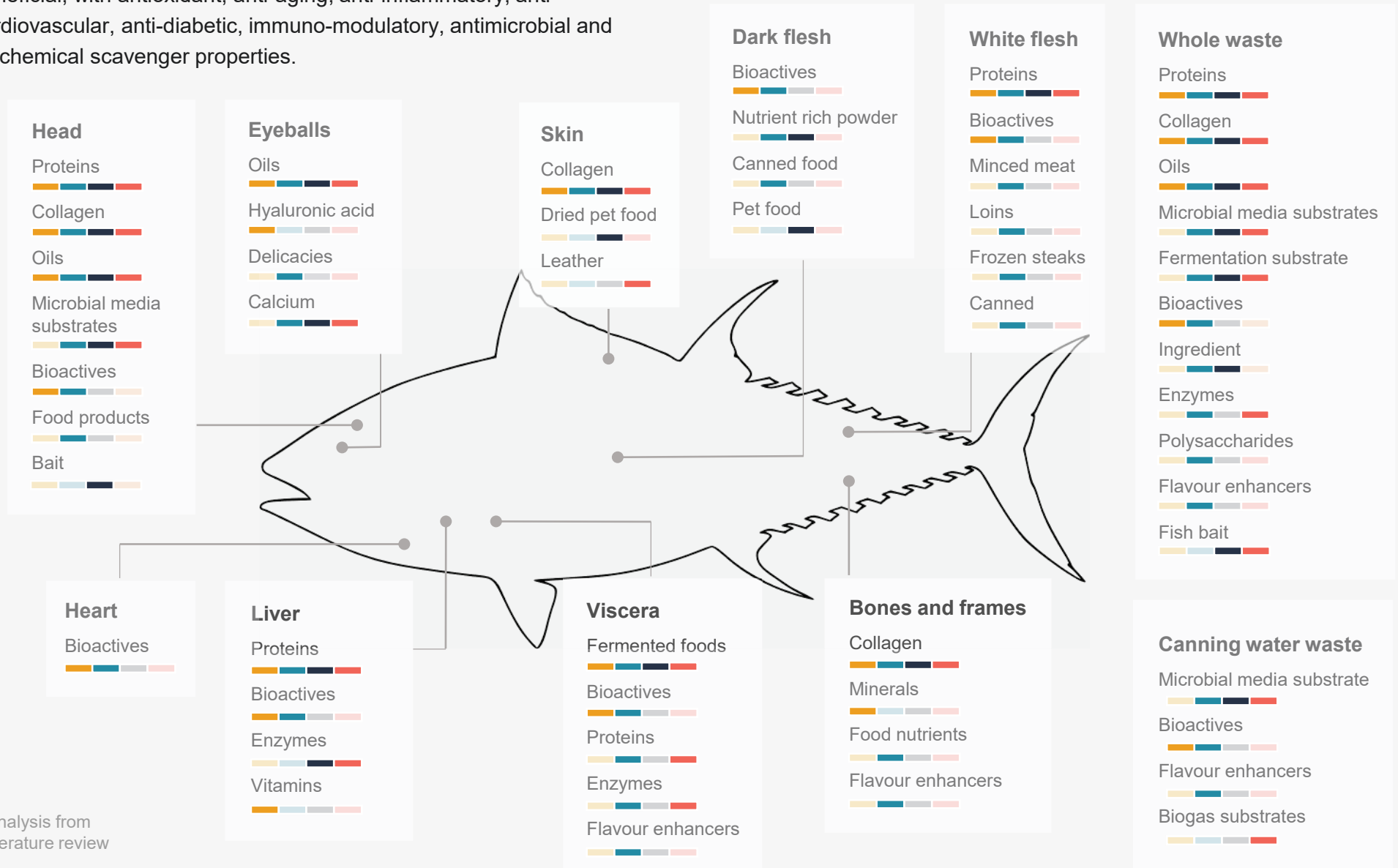
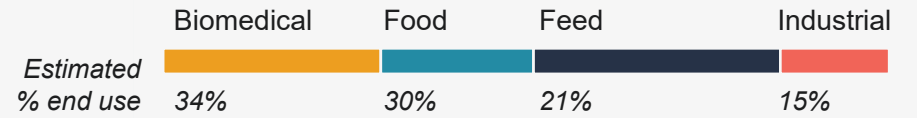
¹ OECD/FAO (2022)

² FAO (2022). Production for human consumption.

³ Del Carmen Gómez-Guillén et al. (2009)

Tuna's potential across a wide range of end products demonstrates its versatility.

Bioactive peptides are derived from tuna protein and are particularly beneficial, with antioxidant, anti-aging, anti-inflammatory, anti-cardiovascular, anti-diabetic, immuno-modulatory, antimicrobial and biochemical scavenger properties.



Analysis from literature review

Key uses and benefits



● Biomedical ● Food ● Feed ● Industrial

Medical dressing and film: Improved external and internal wound healing. Internally self-dissolving, minimal human body rejection.

Capsule casings: Controlled drug release.

Collagen protein: Improved skin, muscle and ligament integrity. Major structural component lost with age, pivotal role in tissue development.

Vitamins A and D: Natural source.

3D printing material: Improved fabrication properties.

Volatile fatty acids: Acetic, propionic acid, butyric acid.

Biogas production: Methane, ethanol manufacture.

Bioactive peptides: Anti-oxidant, anti-aging, biochemical scavengers.

Microbial media: Enhances growth of bacteria and microbial production of specific compounds.

Food processing technology aid: Improved textural and nutritional food properties.

Food additives and fortified foods: Increased protein content, bioactive peptides, Vitamin A and D, minerals and trace elements.

Hyaluronic acid: Beneficial for skin and joints as a water binder.

Tuna silage: Increases biological quality of feeds.

Fermentation products: Enzymes, substrates for increased microbial production of biosurfactants, amino acids.

Fish sauce, fermented foods: Flavour enhancer, improved nutrient absorption

Food preservative: Anti-bacterial, anti oxidant, longer storage life.

The global volume of tuna landings increased from 4.61 million tonnes in 2012 to 5.18 million tonnes in 2018, a CAGR of 1.97 per cent¹. Pacific flagged states experienced the highest growth rate in landings during this period, i.e., where a vessel is flagged/licenced/registered (refer Figure 2).

The significant growth in landings for FSM, Kiribati and Solomon Islands over the period 2012-18 (refer Figure 2) was driven by growth in the size of their purse seine fleets. Since 2018, the volume of landings in Nauru and Tuvalu has also grown considerably as a result of additional purse seine vessels in their national fleets. Conversely, key countries such as the Philippines, Japan and US experienced negative growth over the same period. The notable reduction in tuna landings experienced by the Philippines is primarily due to overfishing coupled with climate change affecting tuna stocks, highlighting the importance of close monitoring to ensure stocks are kept at sustainable levels².

Purse seine and longline are the two main gear types, responsible for 67 per cent and 11 per cent of global catch by volume respectively in 2018¹. The remaining gear types – pole and line, handline, gill net and troll – contributed less than 6 per cent each in the same year. Gear type is a key determinant of tuna end use, with purse seine-caught tuna generally used for high volume, low value products compared to longline-caught tuna, which caters for the low volume, high value market (refer Table 1). The value of longline-caught tuna is in value preservation and therefore purse seine-caught tuna is predominantly used for food product innovations.

Most tuna is caught from the WCPO although minimal processing occurs in the region. Thailand, Ecuador, Spain, Indonesia, Mexico and the Philippines lead the world in canned tuna/cooked loin processing.

¹ Poseidon Aquatic Resource Management (2020)

² Macusi et al. (2017), Suh & Pomeroy (2020)

FIGURE 2

Pacific flagged states experienced the highest growth rates in tuna landings over the period 2012-18

Excludes countries contributing <1 per cent to global landings

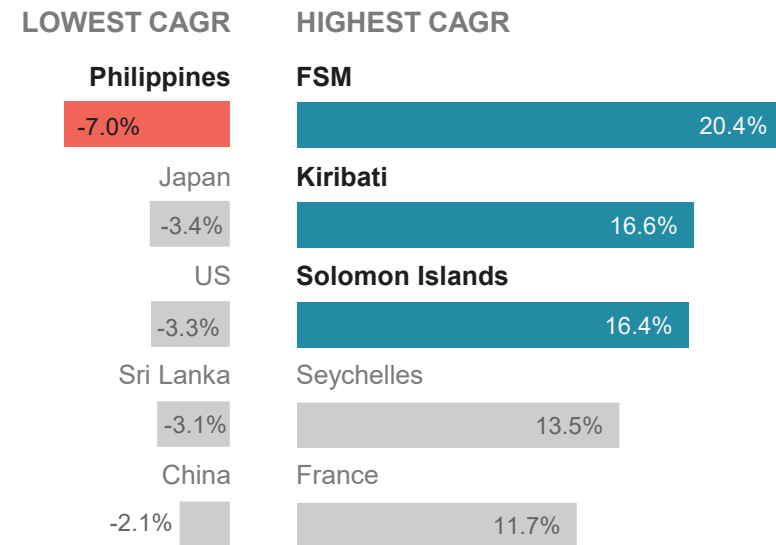


TABLE 1

Average value of purse seine-caught tuna compared to longline (global)

2018, US\$ per tonne

	Purse seine	Longline
Dock/first sale ex-vessel	1,551	5,915
Final consumed end value	5,032	13,732
	+224%	+132%

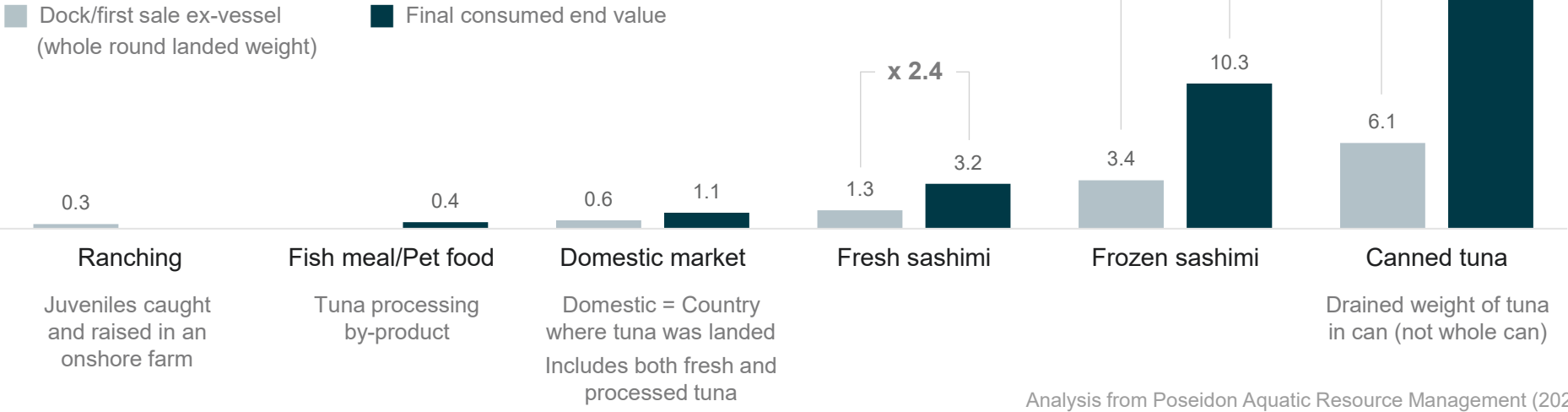
Analysis from Poseidon Aquatic Resource Management (2020)

The value of the global tuna market was US\$42.2 billion in 2022 and is projected to reach US\$50.2 billion in 2028¹.

FIGURE 3

Canned tuna has the highest ratio of final consumed end value compared to dock values

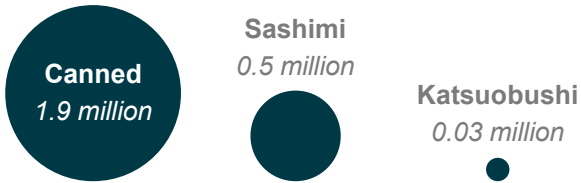
Global tuna market, 2018, \$ billion



Global consumption

metric tonnes

Canned, sashimi 2018
Katsuobushi 2019



Source: Havice et al. (2022)

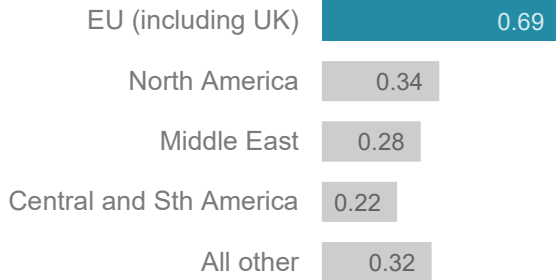
Key markets

SASHIMI (FRESH/FROZEN)

Japan
US (small, growth market)

Source: Havice et al. (2022)

CANNED TUNA (million metric tonnes)



¹ imarc (2021)

Pacific economic and socioeconomic landscape

The Pacific region is highly vulnerable to shocks given its geographic and structural characteristics. Supply chain disruptions and global inflation, as seen in recent years, as well as extreme weather events and natural disasters such as earthquakes, tropical storms and cyclones are significant constraints to the region's human and economic development. Coupled with an increasing reliance on imported food, the region is facing increasing risks to food security.

Solomon Islands, Kiribati and Tuvalu are considered some of the Least Developed Countries (LDC) in the world by the United Nations, with Vanuatu progressing from LDC status only recently. Although not considered LDCs, Marshall Islands and FSM both rank in the worst scoring countries for EVI (Economic and Environmental Vulnerability Index) and Economic Vulnerability (EVI sub-index) respectively, signifying very high structural vulnerability to shocks¹.

The Pacific region is situated along the Ring of Fire and many PICs have low-lying coastal zones, making these countries particularly vulnerable to natural disasters. Average economic losses to the region as a result of natural disasters is estimated to be US\$1.075 billion per year, with 49.6 per cent attributable to tropical cyclones – equivalent to nearly 5 per cent of combined GDP for Pacific small island developing states².

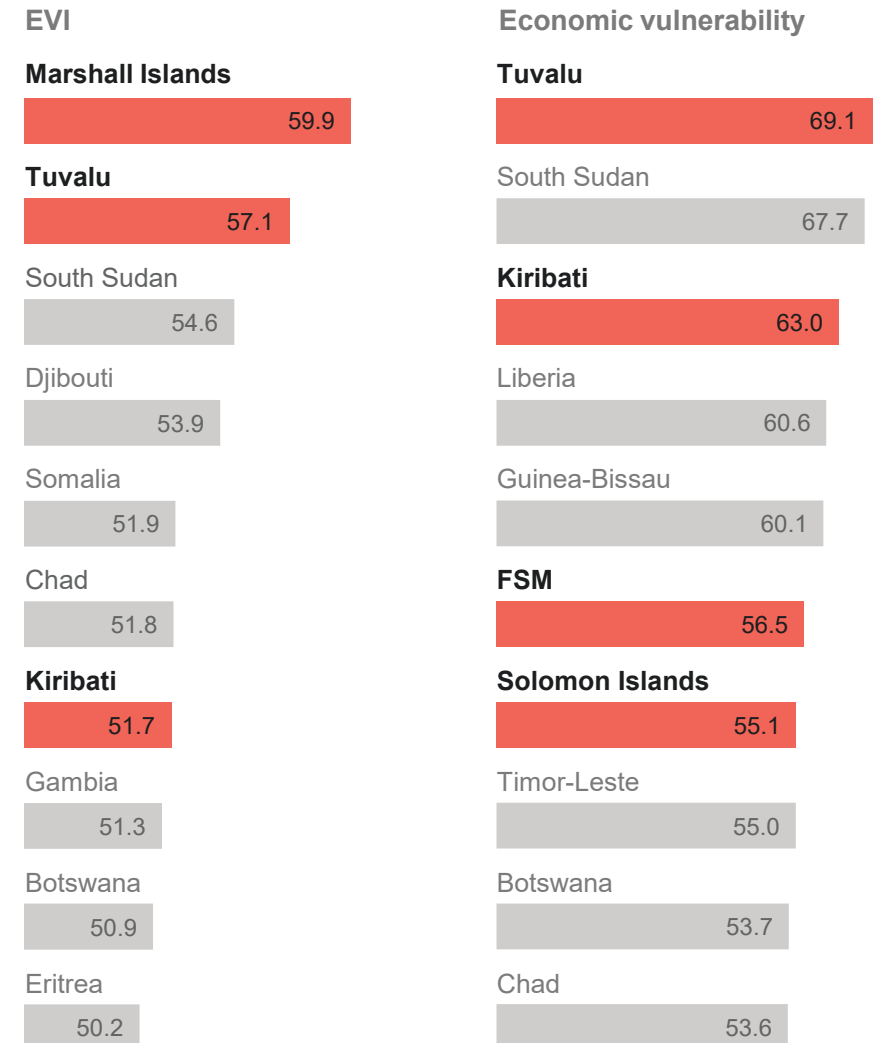
¹ UNCTAD (n.d.)

² United Nations Economic and Social Commission for Asia and the Pacific (2020)

FIGURE 4

Pacific Island countries are some of the most economically and environmentally vulnerable countries in the world

10 WORST SCORING COUNTRIES, 2021 (index 0-100)



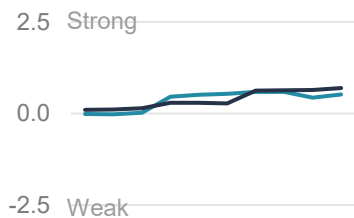
Countries such as Samoa, Fiji and Kiribati have made significant strides towards improving the effectiveness of government and control of corruption over the past decade, although other countries have deteriorated.

FIGURE 5

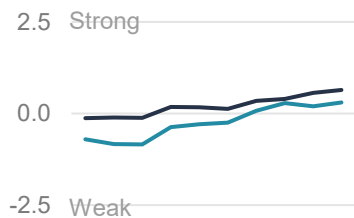
Government effectiveness and control of corruption indices, 2011-20

— Government effectiveness (+/- growth)
 — Control of corruption (+/- growth)

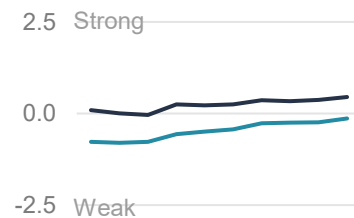
SAMOA



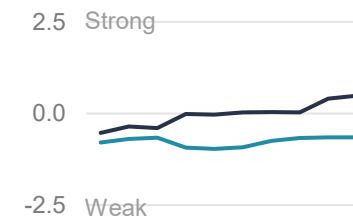
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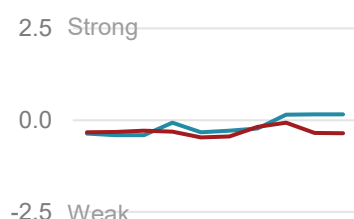
KIRIBATI



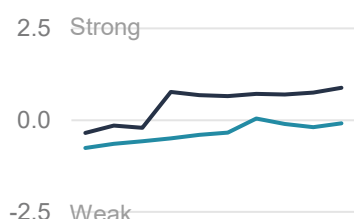
TUVALU



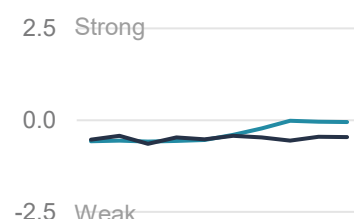
TONGA



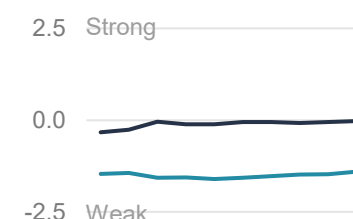
FSM



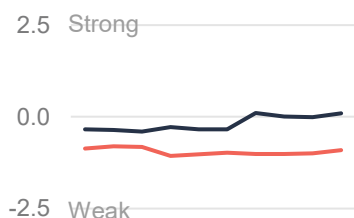
PALAU



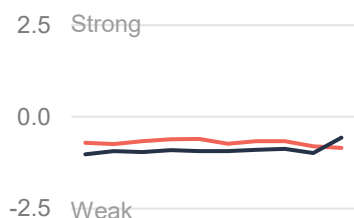
MARSHALL ISLANDS



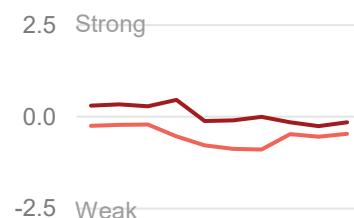
SOLOMON ISLANDS



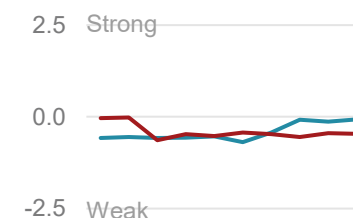
PAPUA NEW GUINEA



VANUATU



NAURU



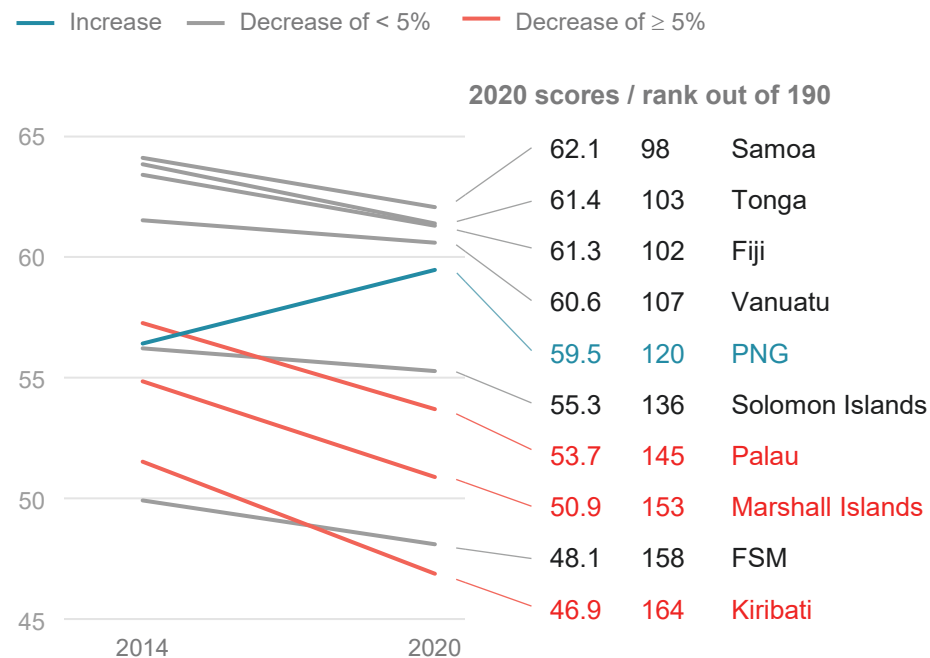
Analysis from World Bank (n.d.), World Governance Index data

The region’s business environment has also progressively deteriorated with Papua New Guinea the only country to improve its ease of doing business score since 2014.

The cost and reliability of electricity is particularly poor with most PICs experiencing electricity connection costs of more than 500 per cent of income per capita and electricity tariffs in the Solomon Islands the highest in the world with an average cost of US\$0.692 per kilowatt hour¹.

FIGURE 6

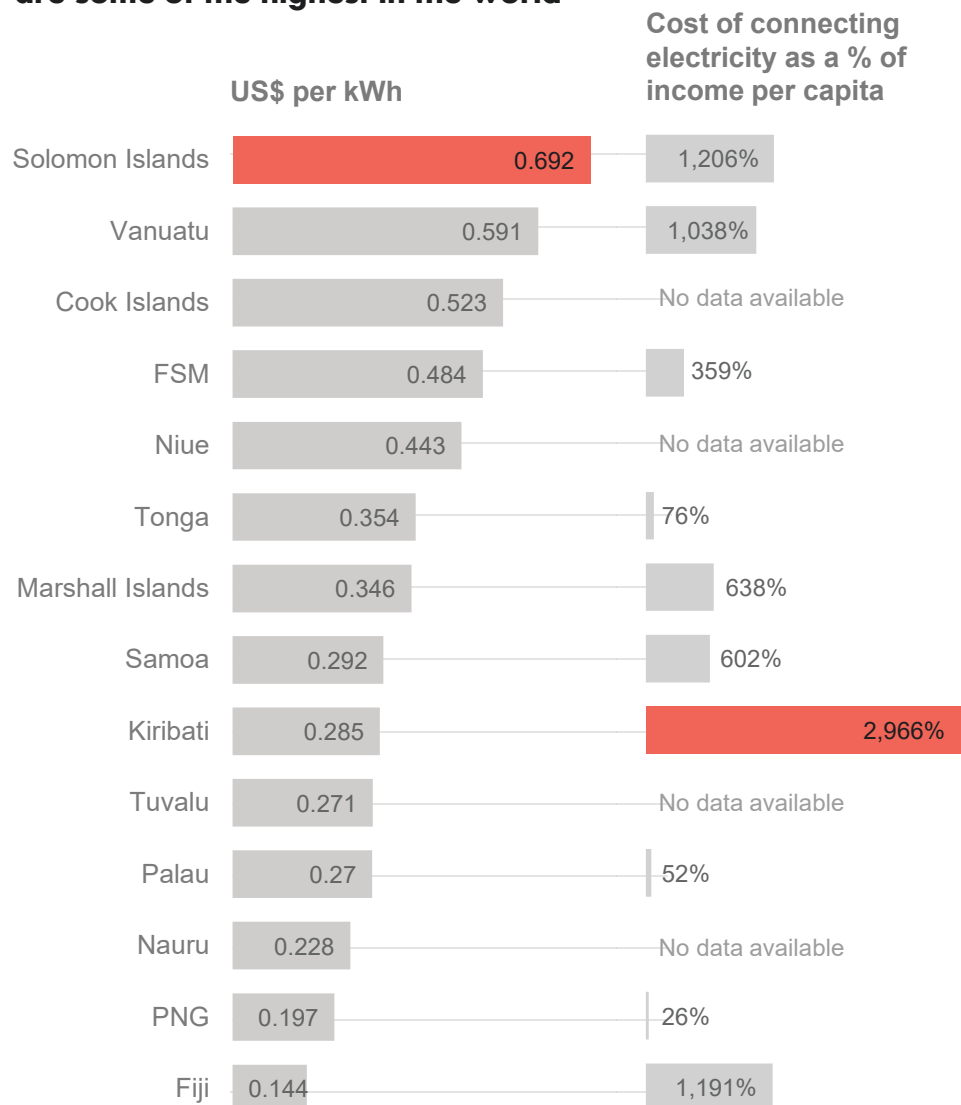
Ease of doing business scores



Analysis from World Bank (n.d.), Ease of Doing Business data

FIGURE 7

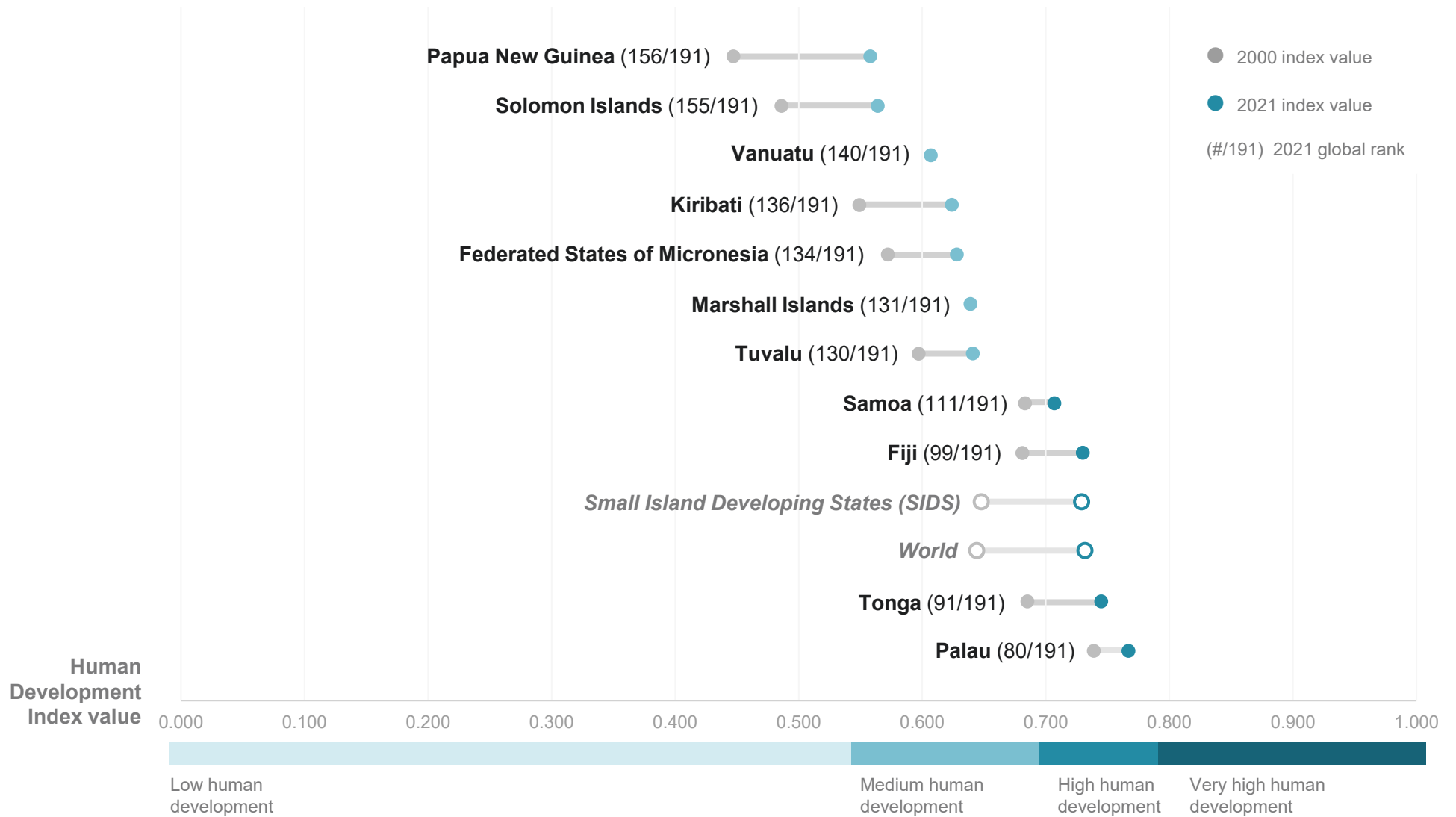
Electricity costs in the Pacific region are some of the highest in the world



Analysis from Cable.co.uk (2023) and World Bank (n.d.), Ease of Doing Business data

¹ Cable.co.uk (2023)

The Pacific region has seen improvement across health, education and standards of living over the past two decades.



Analysis from United Nations (2022), Human Development Index data

1. No data available for Cook Islands, Nauru, Tokelau and Niue.
2. No 2000 index data available for Marshall Islands and Vanuatu

Yet the impact of population growth and urbanisation has been detrimental to the overall health of the region's population.

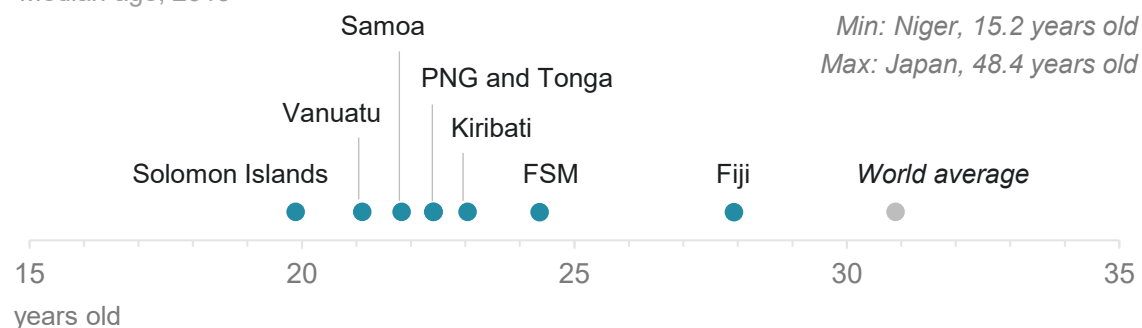
A shift in dietary preferences is the primary driver, with the increased availability of cheap, processed foods through imports contributing to the significant issue of non-communicable diseases (NCDs) (refer Figure 8). This in turn has influenced the region's median age, which is notably lower than the world average (Figure 9).

While this should lead to the increased availability of labour for the region's workforce, the Pacific has simultaneously been experiencing a 'brain drain' with locals migrating overseas for more attractive job opportunities, reflected in the significant levels of personal remittances being received by the Pacific. Tonga leads the world in personal remittances received as a percentage of GDP at 46.2 per cent in 2021 (ranked 1/179), with Samoa following closely behind at 29.4 per cent of GDP (4/179)¹. This dynamic has been exacerbated by labour mobility schemes, which are designed to address workforce shortages in places like Australia while providing additional job opportunities for the Pacific's working age population.

FIGURE 9

The Pacific population's 'youth bulge'

Median age, 2019



Analysis from United Nations (2022), Human Development Index data

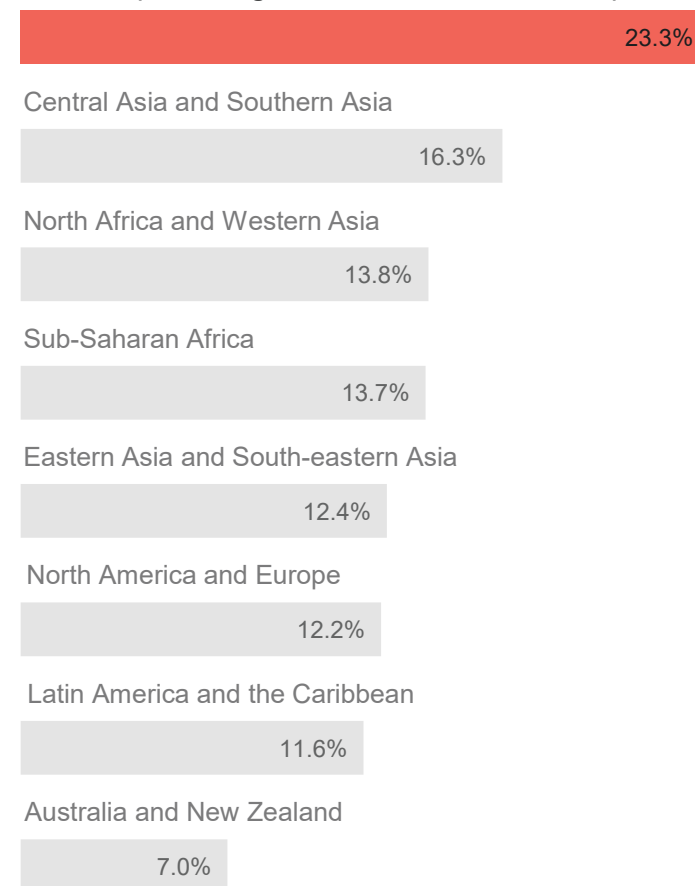
¹ World Bank (n.d.), World Development Indicators 2021

FIGURE 8

Probability of dying between age 30 and 70 from any of the four main NCDs

Cardiovascular disease, cancer, diabetes, or chronic respiratory disease, 2019

Oceania (excluding Australia and New Zealand)



Analysis from World Health Organization (n.d.), The Global Health Observatory data

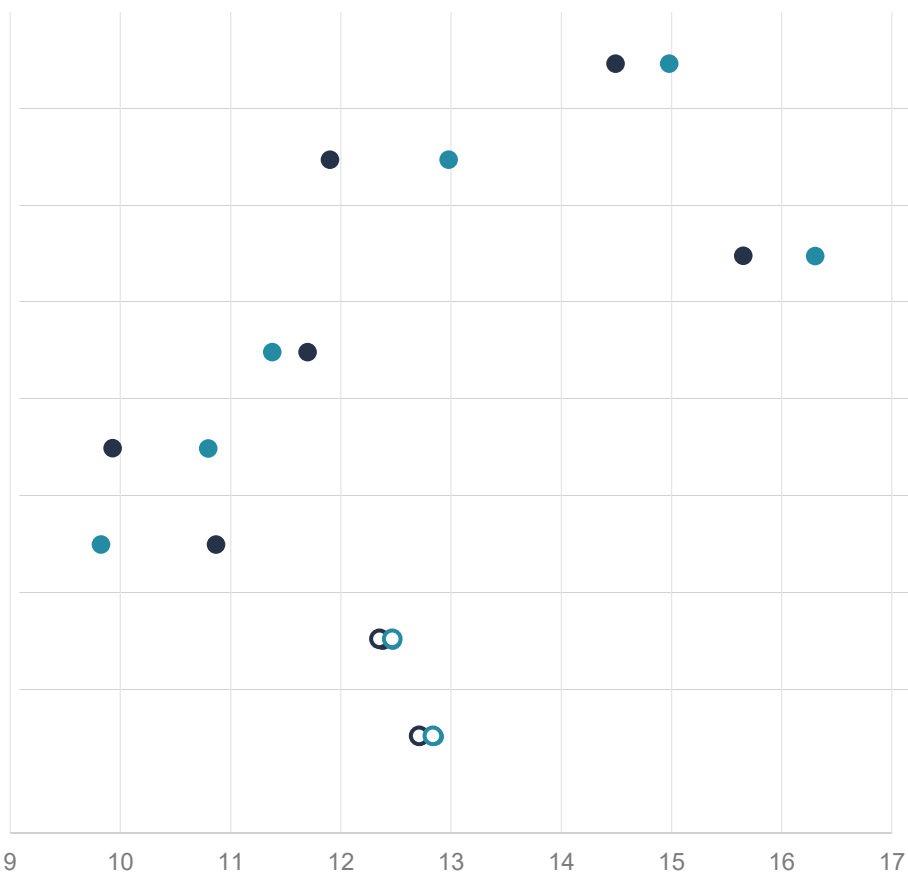
From a gender perspective, females are receiving more years of schooling than males across most of the Pacific, yet this is not translating to labour force participation.

FIGURE 10

Years of schooling compared to labour force participation, 2021

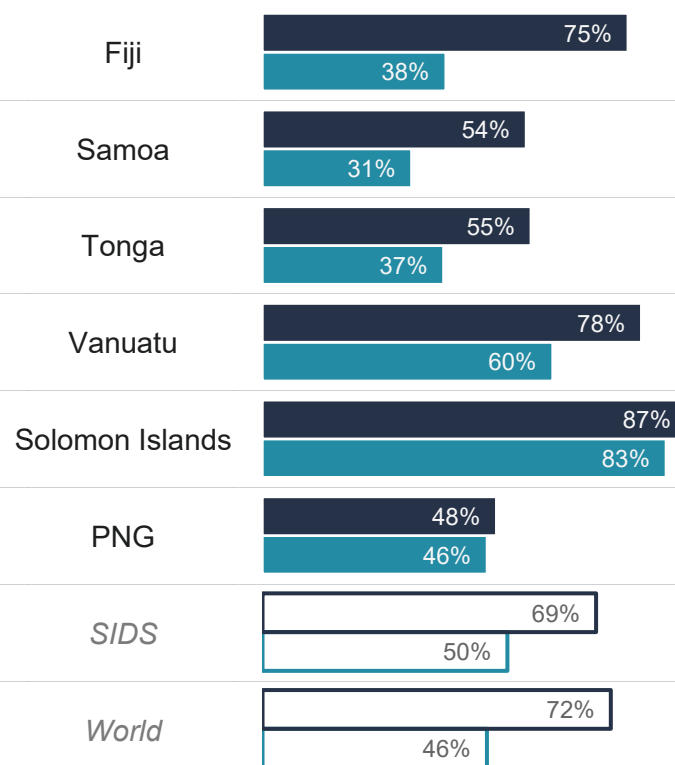
EXPECTED YEARS OF SCHOOLING

● Female ● Male



LABOUR FORCE PARTICIPATION RATE (%)

Labour force divided by total working age population (between 15 and 64 years of age)



Women often bear the burden of family and cultural obligations, impacting their ability to participate in the workforce.

years

Analysis from United Nations (2022), Human Development Index data

Pacific tuna sector

The Pacific tuna sector is export driven, with most exports comprised of intermediate products that are destined overseas for processing into final product.

Tuna fisheries in the WCPO have contributed 53 to 58 per cent of global catch over the past decade for albacore, bigeye, skipjack and yellowfin tuna¹, yet the Pacific sector struggles to compete with the likes of Indonesia and the Philippines, which are proximate to both fish supply and end markets.

Purse seine catch volumes have steadily increased over the past few decades as a proportion of WCPO total catch volumes for all fleets, from 57 per cent in 1997 to 70 per cent in 2021. Conversely, longline catch volumes have decreased, from 13 per cent in 1997 to 7 per cent in 2021¹.

¹ Pacific Island Forum Fisheries Agency (2022a)

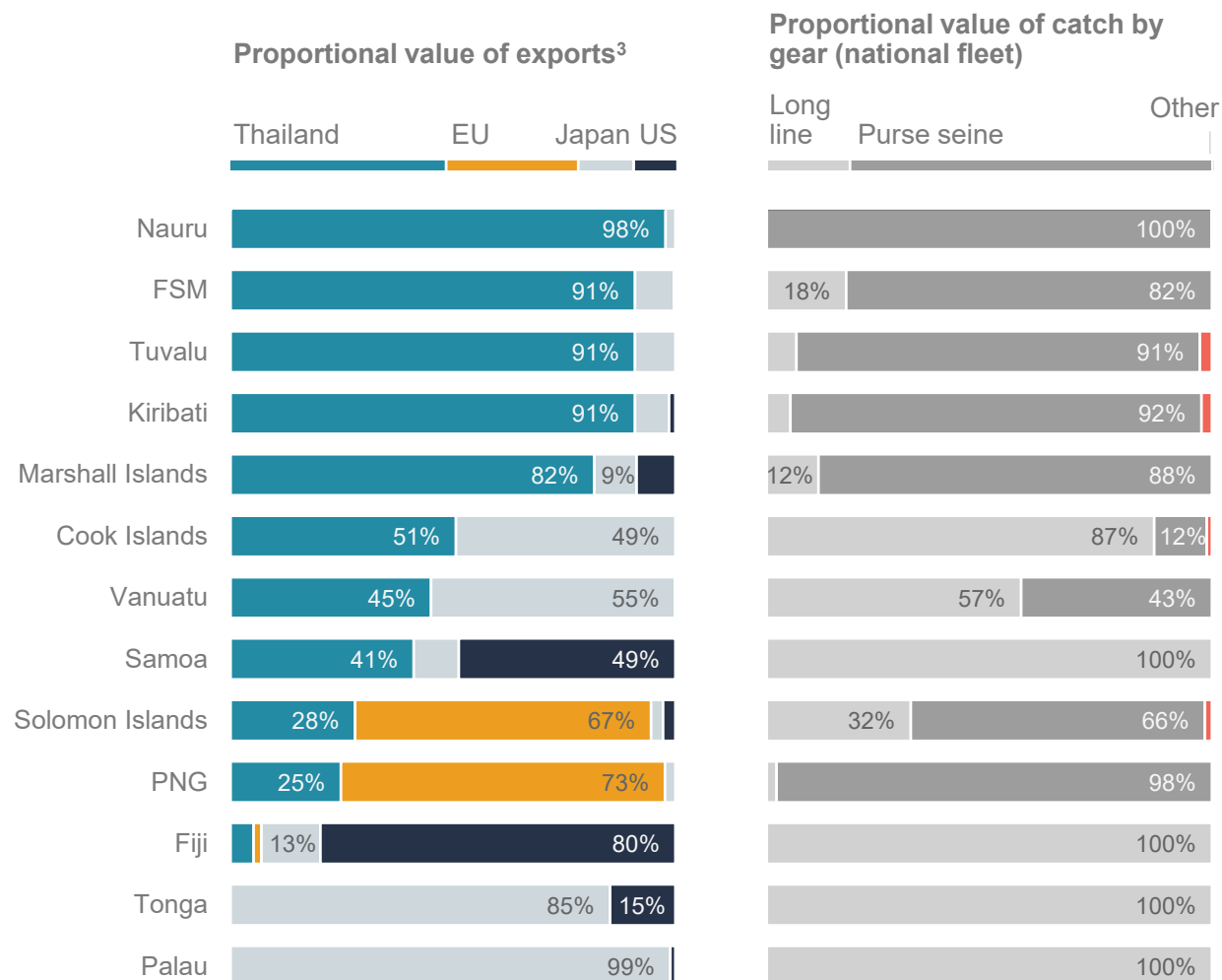
² 2017-21 average used to smooth out the effects of COVID.

³ No exports from Tokelau or Niue.

FIGURE 11

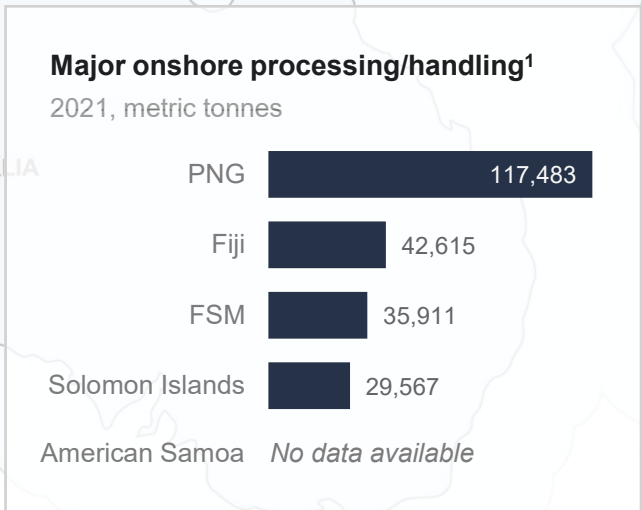
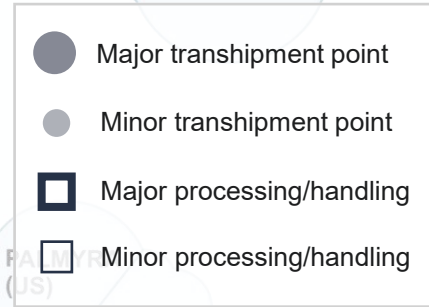
Thailand is the most important export market for the Pacific tuna sector

FFA members, 2017-21 averages²



Analysis from Pacific Island Forum Fisheries Agency (2022a) data

The Pacific tuna sector plays a key role in the global tuna market.



Derived from Pacific Island Forum Fisheries Agency (2022a) and The Pew Charitable Trusts (2019).

¹ Processing data available for FFA members only. Volume processed refers only to longline/purse seine catch processed to some form domestically onshore or on-board vessels; excludes volumes transhipped or delivered directly to offshore canneries. Handling includes sorting and containerisation.

² American Samoa is not an FFA member but has been included on the map given major processing activity in country.

The structure of the tuna sector varies across Pacific Island countries.

Key influencing factors include:

- The size of the country's EEZ.
- Tuna stocks.
- Country's geographic position and proximity to key markets.
- Infrastructure such as ports.

¹ The volume processed refers only to longline/purse seine catch processed to some form domestically onshore or on-board vessels; excludes volumes transshipped or delivered directly to offshore canneries. Includes handling and containerisation.

² Primarily handling (sorting and containerisation).

TABLE 2

The tuna sector is an important contributor to most Pacific Island economies

FFA members; figures averaged over 2017-21

Country	Onshore processing ¹ metric tonnes	Number of people employed	Licence and access fees US\$ million	Catch volume: National waters metric tonnes	Catch volume: National fleet metric tonnes	Onshore processing as % of catch volume: National waters
PNG	101,620	12,497	105.8	428,690	251,498	24%
Fiji	48,409	3,896	2.2	8,975	13,494	548%
FSM	25,976	654	71.4	199,003	144,773	15%
Solomon Islands	24,733	3,321	39.9	112,675	52,995	24%
Marshall Islands	11,170	953	31.4	39,892	83,700	41%
Samoa	5,107	307	1.3	1,872	2,570	264% ²
Tonga	2,000	287	1.5	1,663	269	118%
Vanuatu	962	596	2.4	6,307	39,761	35%
Kiribati	877	1,069	128.5	439,347	197,464	0%
Cook Islands	179	90	11.3	23,776	4,062	1%
Palau	0	34	8.9	7,049	1,592	0%
Tuvalu	0	125	27.6	87,610	13,189	0%
Nauru	0	110	41.6	130,353	50,879	0%
Tokelau	0	7	14.4	21,044	120	0%
Niue	0	4	1.1	231	0	0%



Analysis from Pacific Island Forum Fisheries Agency (2022a)

FIGURE 12

The structure of the PNG tuna sector has seen significant change in recent years

In 2018 the PNG tuna sector underwent a change in the way access fees were charged for fishing, moving from concessions to a rebate scheme based on onshore processing volumes (refer [Value chain: Processing](#) for more details).

Despite this change and a resultant decline in PNG-flagged vessels, there has been minimal impact on licence and access fee revenue due to the rebate scheme and PNG’s EEZ benefiting from the El Niño Southern Oscillation (ENSO), which has resulted in increased tuna stocks due to the warmer waters.

PNG’s processing sector has also benefited from global sourcing arrangements that have been in place since 2008, providing preferential access for the EU market (refer [End markets: International](#) for more details).

The decline of PNG’s national longline fleet has been driven by high airfreight costs. Purse seine-caught tuna, in comparison, is shipped by sea.

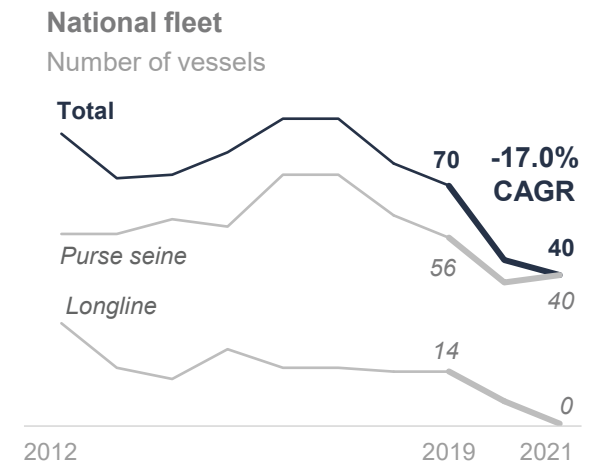
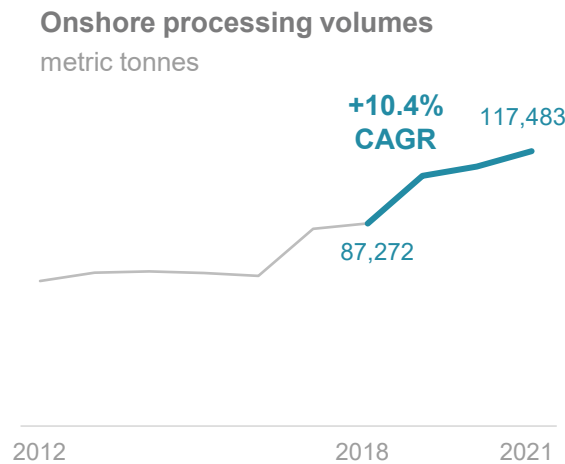
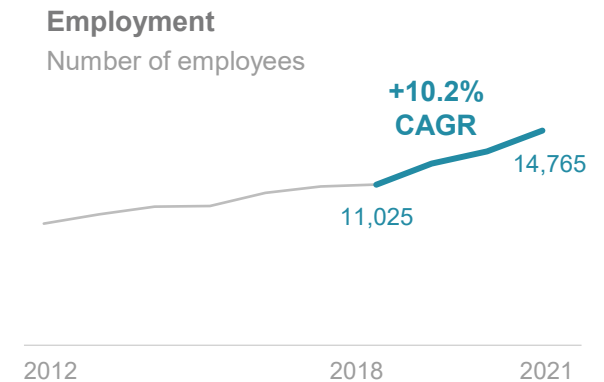
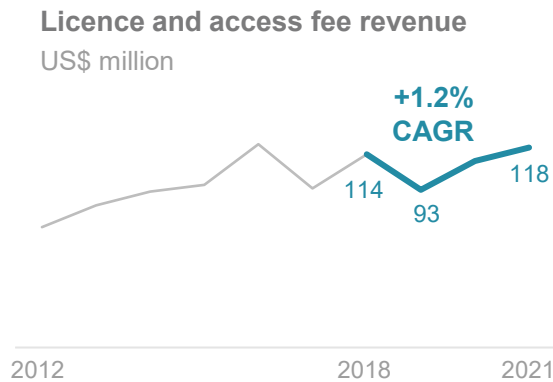
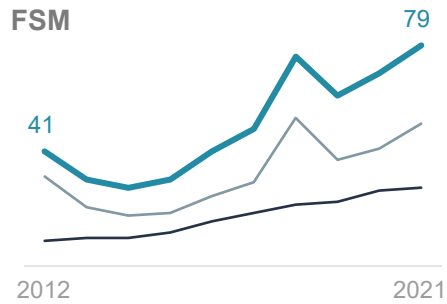


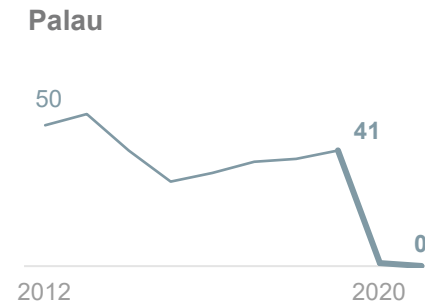
FIGURE 13

There have also been significant changes to national fleets over the past decade

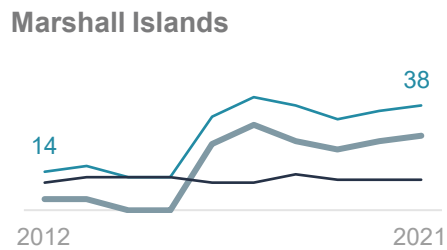
— Total number of vessels — Longliners — Purse seiners



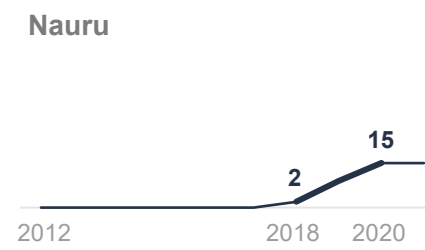
FSM's national fleet growth reflects growth in one Chinese company's longline fleet (frozen tuna), and lower access fees attracting purse seiners from other Pacific Island countries.



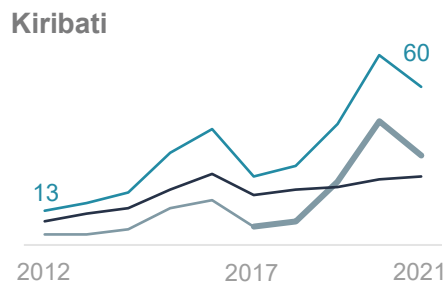
The Palau National Marine Sanctuary came into effect in 2020, protecting 80% of Palau's EEZ with the remaining 20% designated as a domestic fishing zone.



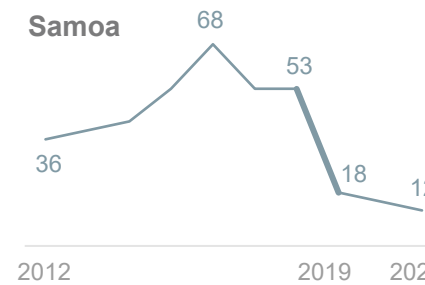
Marshall Island's fresh longline fleet is owned by the same company that owns the fleet in FSM. The integrated business owns aircraft and distribution into the US market, insulating it from the effects of COVID.



Growth in Nauru's national fleet has primarily been driven by vessels reflagging from PNG to Nauru.



Kiribati's longline fleet is mainly for frozen tuna, and in fact continued to experience growth throughout COVID.



After reaching a peak of 68 vessels in 2016, Samoa's national longline fleet has declined to 12 vessels with a sharp decrease from 2018 to 2019, potentially as a result of COVID.

The tuna sector’s four key areas of employment are harvesting, processing, the public sector and observers.

Processing provides the greatest opportunity for workforce localisation given that it is land based, suited to unskilled labour and is less physically demanding than harvesting.

The majority of the processing workforce is comprised of women, estimated at 70 per cent, whereas women represent only 30 per cent of the workforce for the public sector and 1 per cent for both harvesting and observers¹.

FIGURE 14

Employment by segment, 2021

Total for FFA members

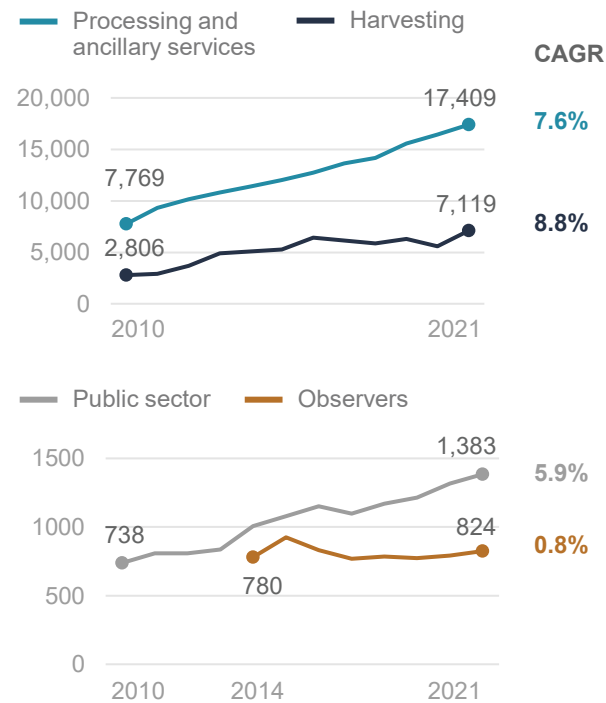
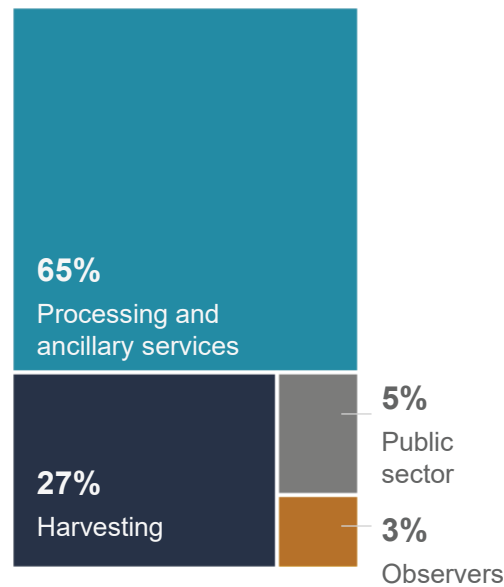
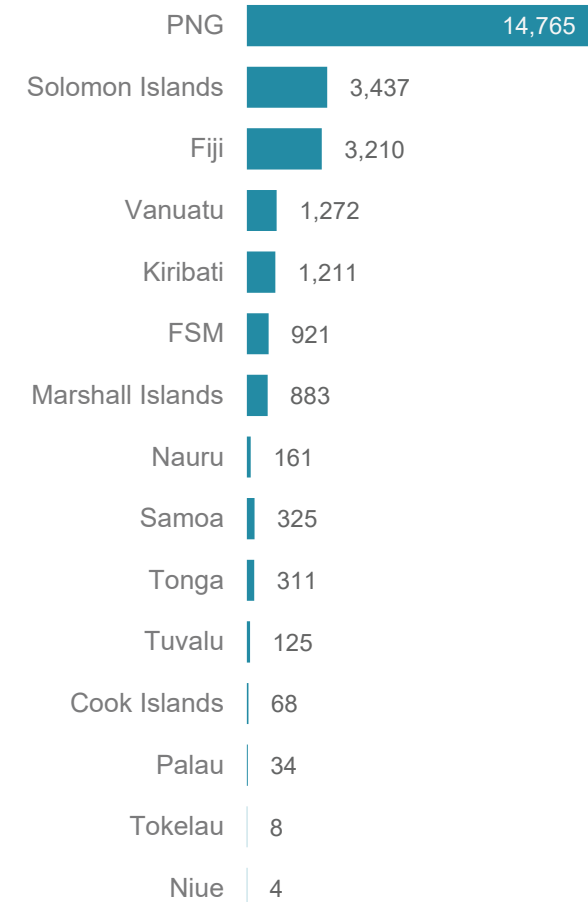


FIGURE 15

Tuna sector employment by PIC, 2021

Total number of people employed



¹ Barclay et al. (2021)

Although demand for tuna remains relatively stable, balancing the tension between maintaining sustainable stocks and the economic viability of the Pacific tuna sector will become increasingly challenging.

Bargaining power of buyers	Bargaining power of suppliers	Rivalry among existing competitors	Threat of new entrants	Threat of substitute products/services
HARVESTING				
<p>High</p> <p>Limited markets due to the following:</p> <ul style="list-style-type: none"> Type of vessel and equipment (e.g., freezing capability) limits tuna end use and therefore market options. Market access conditions, e.g., country must be a Competent Authority to access the EU market; Marine Stewardship Council (MSC) requirements. <p>Trading companies hold the most power in the value chain as they are able to aggregate catch, hold key relationships and are a primary source of information.</p>	<p>Moderate to high</p> <p>Suppliers include trading companies, ports, repairs and maintenance services, etc.</p> <p>Limited options in the Pacific region therefore competition is low, increasing their bargaining power.</p>	<p>High</p> <p>Particularly between the domestic/PIC fleet and DWFNs.</p>	<p>Low – High barrier to entry</p> <p>Significant capital investment required to purchase fleet, cost of licences, etc.</p> <p>Complex regulatory environment, e.g., sustainability measures, preferential trade agreements.</p>	<p>Low</p> <p>The only current alternative to wild-caught tuna is ranched tuna, with farmed tuna in its nascent stage. Unlikely to farm tropical tuna species, and if so, would focus on tuna for the high-value sashimi market.</p> <p>Potential for higher quality purse seine-caught tuna to be used as a substitute for longline-caught tuna to produce higher-value products.</p>
PROCESSING AND RETAIL				
<p>Medium</p> <p>Increased pressure from consumers regarding sustainable fishing practices. This is often at cost to the harvester and where historically sustainability certification provided harvesters with access to premium pricing, sustainability certification is increasingly becoming a market access requirement instead.</p>	<p>Low</p> <p>Harvesters are generally price takers. Some long-term contracts but primarily opportunistic selling.</p> <p>Global retail market is dominated by a few key players, giving them high bargaining power.</p>	<p>Low</p> <p>Limited processing capacity in the Pacific; processors source from different harvesters and target different markets.</p> <p>Very few Pacific-based retail brands.</p>	<p>Low – Moderate to high barrier to entry</p> <p>Significant capital investment required to purchase processing facilities and equipment.</p> <p>Strong brand names in the retail segment.</p>	<p>Moderate</p> <p>Other seafood options; however, there are limited direct substitutes given tuna's low cost and versatility.</p> <p>Emergence of vegan-friendly tuna products but no real competition at this stage.</p>

03

VALUE CHAIN

- > **Overview**
- > **Harvesting**
- > **Processing**
- > **End markets**
- > **Service providers**
- > **Key insights**

Overview

The focus of the value chain analysis for this project was to identify opportunities for value addition and waste reduction, key constraints and critical success factors. Given the diversity of tuna sector businesses across the Pacific region and the availability of in-depth value chain research focused on single value chains, a qualitative approach has been taken.

The Pacific tuna value chain is characterised by high barriers to entry, exacerbated by high regional costs of operating (see [Pacific economic and socioeconomic landscape](#)). For example, Tonga is unable to meet even local market demand for tuna due to the lack of vessels and operators, and challenges finding crew¹.

Domestic businesses operating in the Pacific tuna sector can broadly be described as follows:

- Businesses are typically concentrated on a single function (e.g., harvesting).
- Constrained by high operating costs and challenges with achieving scale (refer Figure 16 for an example of comparative processing costs).
- Lack of infrastructure, particularly port facilities, which limits the ability for services to the tuna sector achieving sufficient scale to be financially viable (e.g., net repair). Given that vessels are the most valuable assets for harvesters, the preference is for vessels to be serviced at better equipped ports.

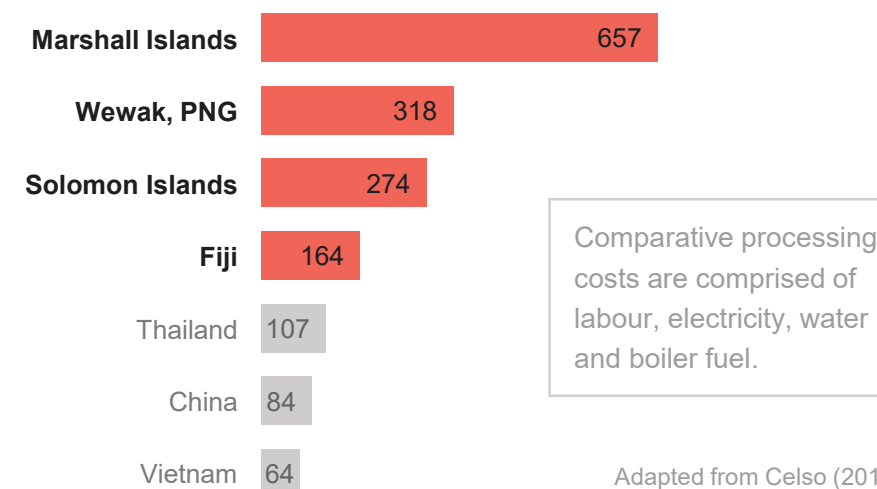
- High shipping and air cargo costs; infrequent and indirect routes to markets.
- Challenges with securing skilled employees, exacerbated by emigration and the small and dispersed population.
- Cultural constraints of workers; customary society at odds with the demands of modern work (e.g., regular working hours).

The Pacific's innovation environment is in its infancy with minimal government incentives or support for even business skills. Emerging talent is reliant on support from international programs, or alternatively emigrating to a more conducive innovation environment. Furthermore, high levels of inherent risk is a deterrent for tuna sector businesses to take on additional risk through innovation.

FIGURE 16

Processing costs are significantly higher in the Pacific

Loining, per metric tonne (US\$), 2015

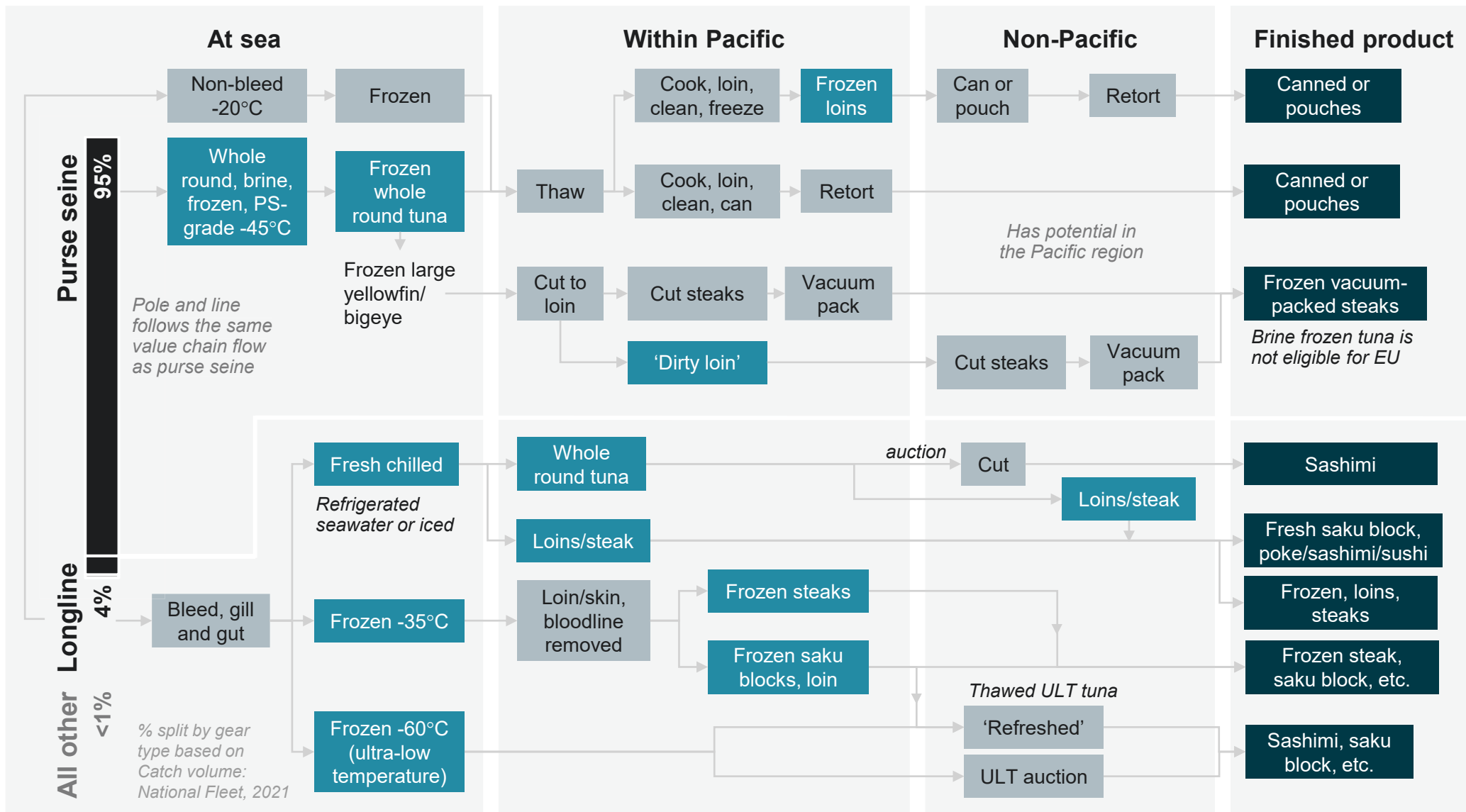


Adapted from Celso (2015)

¹ FFA Media (2022)

Pacific tuna value chain

■ Process ■ Intermediate product ■ Finished product



By-products

Fish meal and fish oil from bones, heads, skin, fins and tails, black meat

Waste

Liquid waste

Other minor product flows include:

- Katsuobushi from pole and line-caught tuna and purse seine-grade fish aggregating device catch skipjack (low fat content).
- Fresh albacore; can be bled and prepared like sashimi yellowfin/bigeye (without being gilled and gutted) to secure a higher price in the Japanese markets.

Analysis from key informant interviews and Pacific Island Forum Fisheries Agency (2022a), i.e., FFA members excluding Australia and New Zealand

Traditional Pacific tuna value chains involve multiple intermediaries, leading to the emergence of disintermediated models that allow increased retention of value along value chain segments.

Information flows are relatively homogeneous throughout the value chain with trading companies holding the most power.

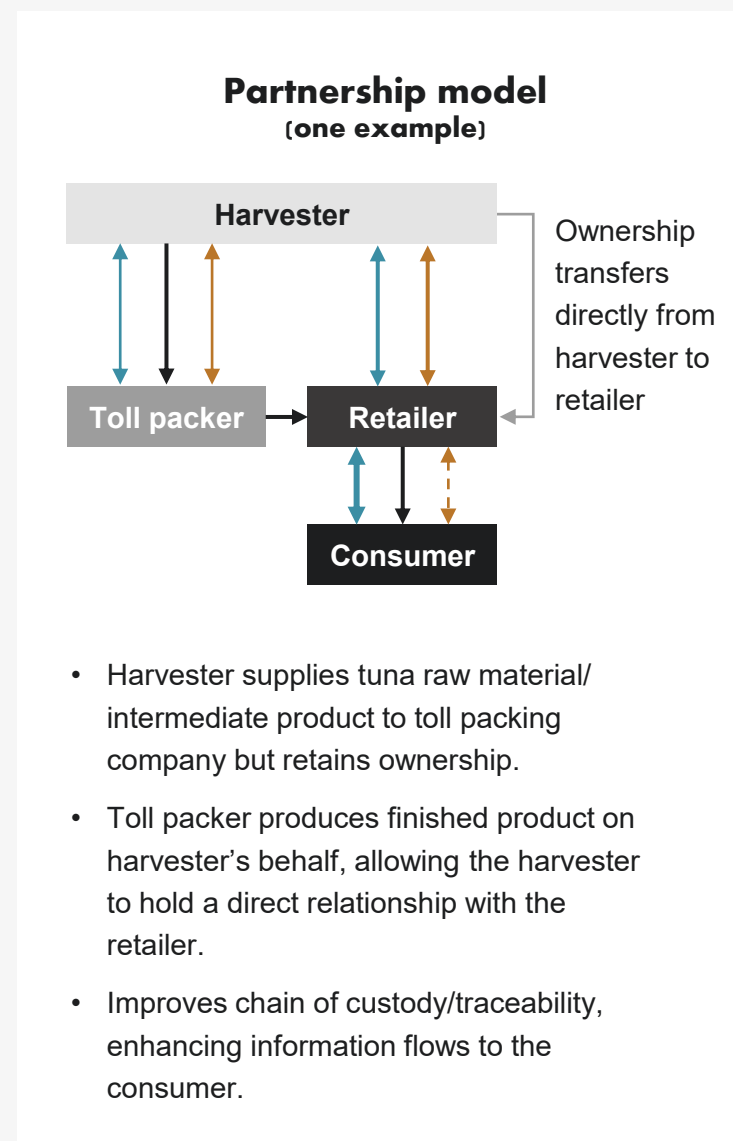
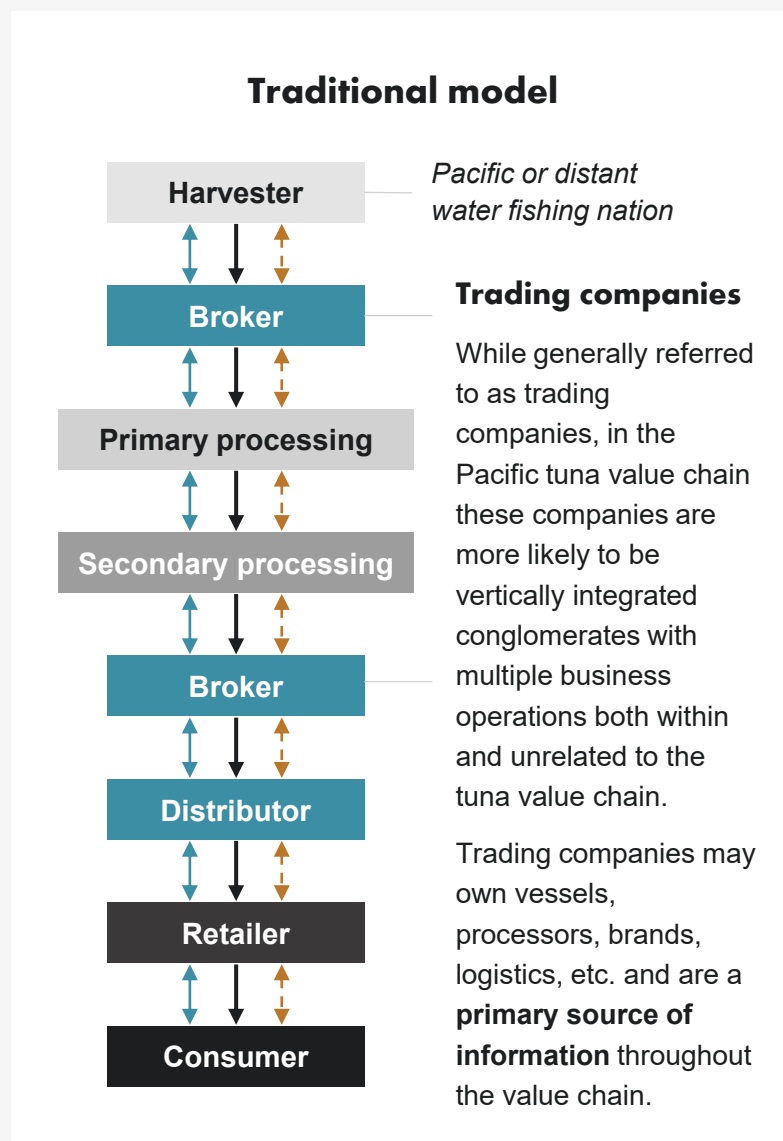
Vertical integration or partnerships are the main options for value chain members to improve product, information and governance flows.

Types of flow

- Product
- Information
- Governance
- Direction of flow

Quality of flow

- Weak
- Moderate
- Strong



VALUE CHAIN

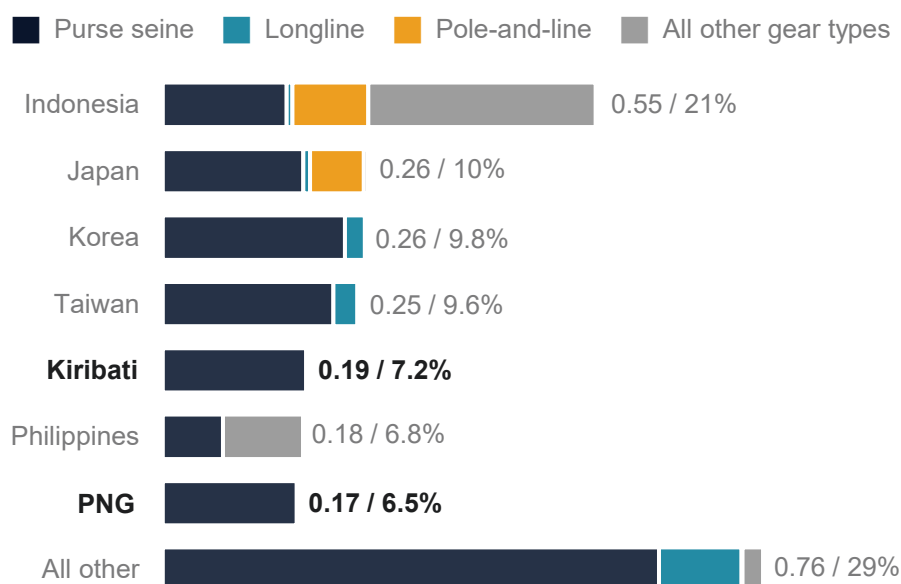
Harvesting

The harvesting value chain segment has the highest risk profile with significant costs involved in purchasing, repairing and maintaining vessels and a limited resale market. Improved vessel sophistication is the primary means of achieving cost efficiencies and improving catch volumes, yet access to finance to fund such upgrades is a challenge for PIC fleets given that banks typically require land-based security. Subsidies are prevalent amongst DWFN fleets harvesting from the WCPO, allowing them to operate well below break-even point.

FIGURE 17

Western and Central Pacific Fisheries Commission Convention Area: Catch volume by vessel nationality

2021, million metric tonnes / % of total catch volume



Analysis of Pacific Island Forum
Fisheries Agency (2022c) data

Fiji's harvesters were badly impacted by COVID-19 (COVID) given a reliance on the US market, air freight costs and flight route limitations, lack of cold storage facilities, impact on tourism for non-export grade tuna, and long-term non-tradeable licences. This combination of factors, amongst others, means that the sector has been constrained in terms of adapting to the changing conditions imposed by COVID. Many Fijian harvesters were still operating below pre-COVID levels when interviewed and most key informants had less than half their vessels operational compared to pre-COVID².

The workforce is comprised predominantly of men, making up 99 per cent of the harvester workforce in WCPO tuna fisheries¹. Key factors driving the low inclusion of women are the lack of appropriate facilities onboard vessels, physically demanding work and family/community obligations. A joint initiative between Seaquest and FFA to champion all-female crews in mid-2022 has seen encouraging results, demonstrating the feasibility of a more gender-inclusive approach.

Senior positions are generally held by expatriates, and recruiting and retaining deck crew is becoming increasingly challenging with harvesters facing competition from other types of vessels with more favourable working conditions (e.g., cargo/container vessels, domestic ferries). Other factors impacting the labour supply include seasonal worker schemes (e.g., Pacific Australia Labour Mobility Scheme) and net emigration from the Pacific region.

The high turnover of crew members means that harvesters are often reluctant to invest in training, and there is limited and/or inconsistent fishing-specific training available from local institutions. The lack of career paths has also impacted on the attractiveness of the sector.

¹ Barclay et al (2021)

² Refer Data Notes, item 7 in [Appendix 3](#).

VALUE CHAIN Processing

Pacific processing plants are located in PNG, Fiji, Solomon Islands, FSM, American Samoa and the Marshall Islands. The region is becoming increasingly mindful of the value of concessions versus the tangible benefits of localisation. For example, most processing occurs in PNG where discounted access fees were historically a driver of onshore investment. This has changed in recent years with the introduction of a rebate scheme, which provides harvesters with a rebate on Vessel Day Scheme (VDS) fees based on a dollar value per metric tonne processed onshore. PNG and Solomon Islands processors also qualify for preferential EU-duty access.

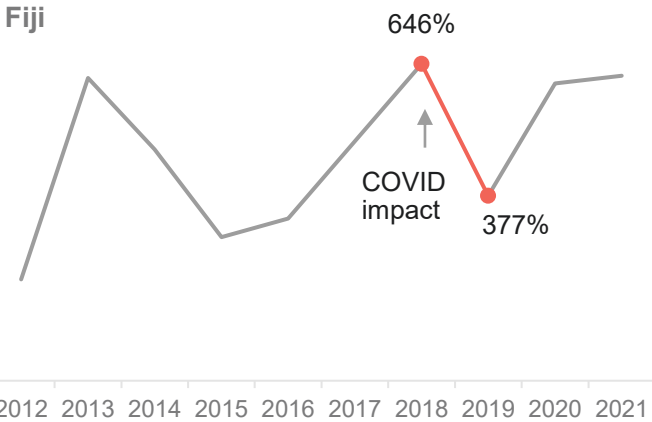
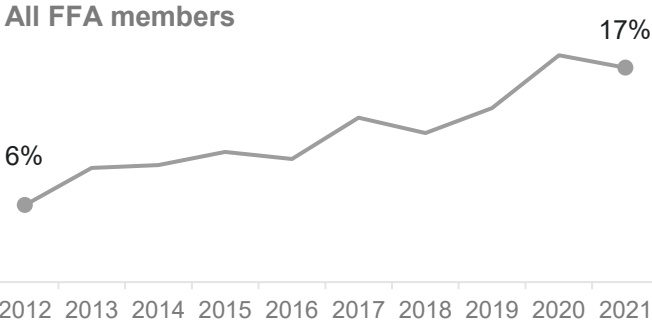
Globally, Thailand, Indonesia, Ecuador, Spain, Mexico and the Philippines are the top canned tuna/cooked loin processing countries by volume (2017 figures), collectively contributing 55 per cent to global production¹. Processing volumes have steadily increased in the Pacific region despite the high-cost operating environment, with processing volumes in PNG the highest by far. Fiji’s processing volumes have significantly exceeded catch volumes from their national waters since 2011 (refer Figure 18), indicating that a significant proportion of tuna processed in Fiji is harvested from other EEZs.

PIC processor resilience to the impacts of COVID was largely insulated/determined by market diversification. As with the harvesting value chain segment, Fijian processors were significantly impacted by COVID with a 41 per cent decrease in onshore processing volumes from 2018 to 2019².

Processing presents the greatest opportunity for generating employment within the tuna sector (see [Figure 14](#)), leading PIC governments to link onshore investment requirements to fishing access rights for DWFNs. Most Pacific processing is primary only, with secondary processing occurring in the main processing countries, where the largest share of value is also captured. Waste is generally processed into lower-value by-products such as fish meal and fish oil.

FIGURE 18
PIC onshore processing volumes have steadily increased over the past decade

Onshore processing volumes as a % of catch volumes in FFA member waters



Analysis of Pacific Island Forum Fisheries Agency (2022a)

¹ Havice & Campling (2018)

² Pacific Island Forum Fisheries Agency (2022a)

VALUE CHAIN

End markets: International

The Pacific region's key export markets are Thailand, Philippines, EU, US and Japan, with exports to Thailand and EU trending upwards. Exports to Thailand and Philippines are mostly whole round tuna, while cooked loins are primarily exported to the EU, US and Thailand.

While exports to the US market have remained relatively stable, exports to Japan have gradually declined. This trend is likely to continue with the projected decrease in Japan's population, changes in consumer preferences and potential competition from farmed tuna (currently bluefin only but yellowfin trials have commenced). Frozen tuna remains the most valuable product for PIC exports followed by loins, both of which experienced minimal impact from COVID. The export value growth of prepared/preserved tuna has been driven by canned tuna, which was a favoured food product for stockpiling during the pandemic given its low price point and shelf stability. Canned tuna product remained backlogged in PNG and many ports globally for many months post COVID due to impacts on border control and the scale down of logistics operations (e.g., available containers), resulting in shipping delays.

The region experienced a significant downturn in exports of fresh tuna (CAGR of -25 per cent between the period 2017 to 2021, falling from US\$53 million to US\$17 million¹) due to lockdowns in overseas markets and limited availability of wide-body jets. The collapse of domestic tourism also impacted demand for non-export grade tuna.

¹ FFA (2022c)

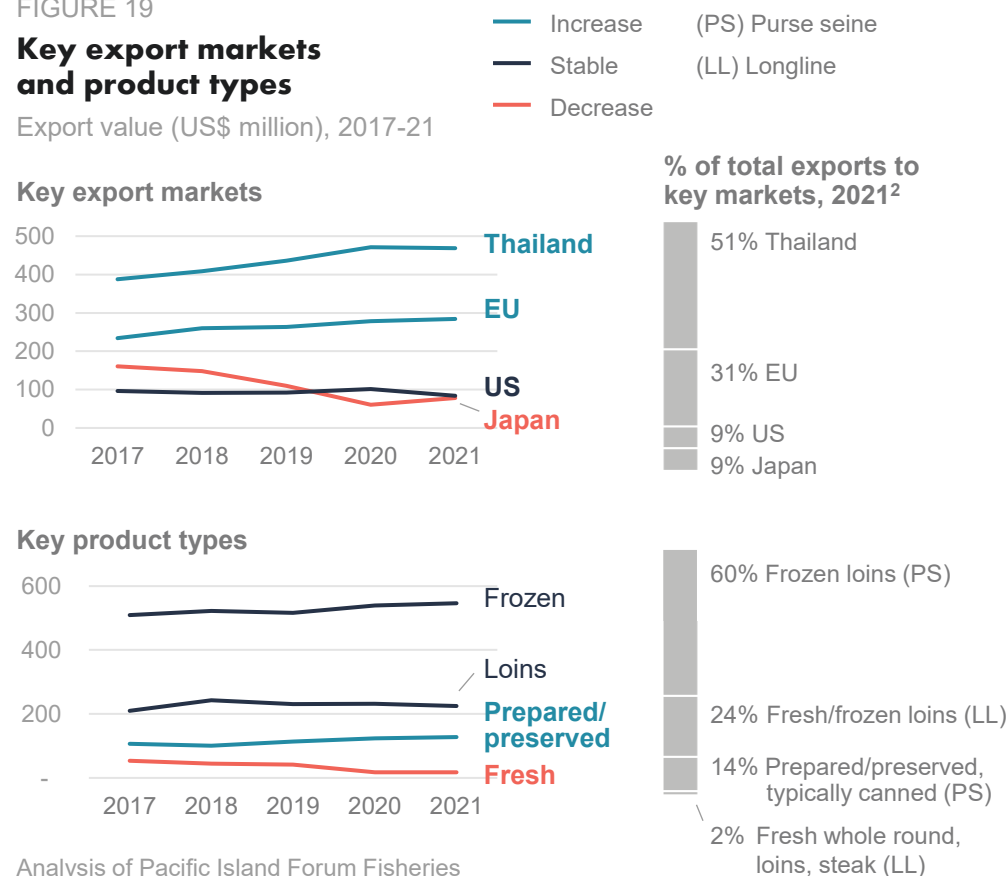
² Refer [Appendix 4](#) for definitions of product types by import country.

The regulatory environment is becoming increasingly complex and stringent – for example, the EU will only accept original copies of vessel catch/health certificates, making it very challenging for smaller PIC businesses to access the EU market given the costs involved. Fiji, Kiribati, Solomon Islands and PNG are the only PICs certified for EU market access as Competent Authorities. EU global sourcing concessions have also been negotiated by the Pacific Island Forum, led by PNG, Solomon Islands and Fiji, which allows for imported fresh/frozen fish to qualify for EU duty-free access if processed in a Competent Authority country, rather than [Rules of Origin compliance](#) requirements applying.

FIGURE 19

Key export markets and product types

Export value (US\$ million), 2017-21



Analysis of Pacific Island Forum Fisheries Agency (2022d) data

VALUE CHAIN

End markets: Regional

Within the Pacific region there are two distinctly different markets – local and tourist markets. However, preferences of the tourist market can influence the local market by encouraging the local population to try new foods, particularly with the younger population. This makes the tourist market a key entry point for the introduction of new products to the Pacific region in countries such as Vanuatu, Fiji and Cook Islands. Distribution channels for tuna products are via wholesalers, markets, supermarkets, restaurants, hotels and local seafood shops.

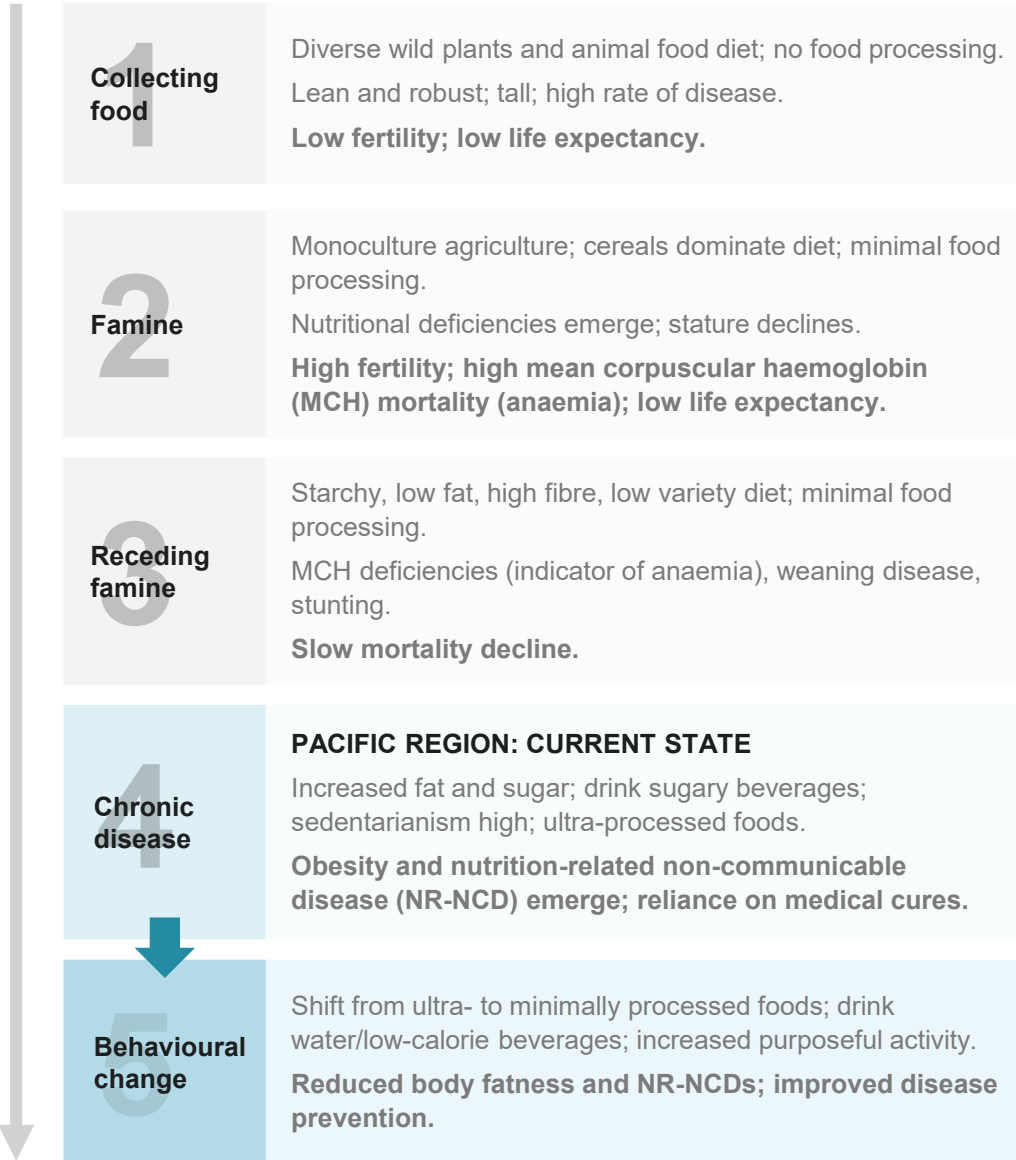
Rural areas are particularly dependent on fish as a protein source, especially in areas where agricultural conditions are not suitable for livestock and there is limited access to other sources of protein such as imported meat. As an ingredient, traditional Pacific recipes tend to use reef fish whereas Central Pacific atoll communities target tuna and other pelagics. Tuna is also commonly used in modern recipes.

The prevalence of non-communicable diseases has led to significant efforts from bilateral/multilateral organisations, governments and NGOs to improve the health consciousness of the local population, to encourage a shift from Stage 4 of the nutrition transition pathway to Stage 5 (refer Figure 20). Initiatives include educational and school lunch programs, and the promotion of locally available foods. This creates an emerging opportunity to introduce convenient and nutritious tuna-based meals to the Pacific market, particularly given the growing proportion of younger people, who are more likely to try novel products.

FIGURE 20

Nutrition transition framework

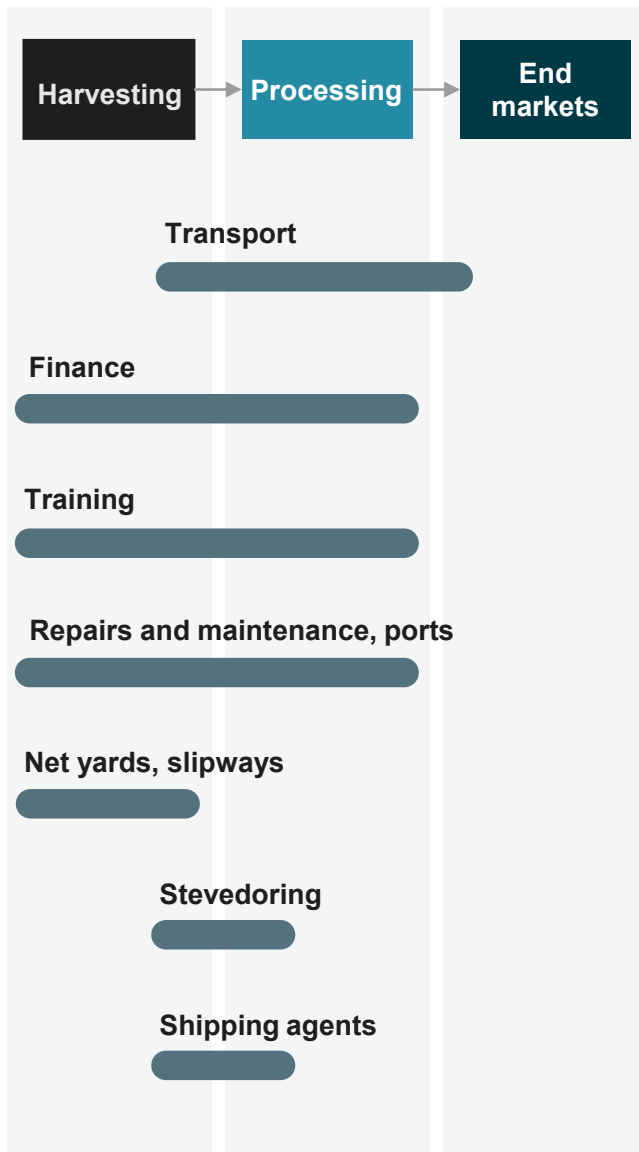
Shift in dietary patterns with social and economic development



Adapted from Popkin & Ng (2021)

VALUE CHAIN

Service providers

**Transport**

- Fresh tuna is typically air freighted to the US, Japan and Australia and other products shipped by sea (dry storage containers for canned tuna; reefer containers for frozen whole round tuna and loins). Most whole round tuna from purse seiners is transshipped with reefer carrier vessels, although an emerging trend is the increased use of reefer containers and tuna exports that have been basically graded.
- Costs of transport have increased significantly post COVID, compounded by a lack of container availability. One key informant cited a cost increase of 150% for full container loads.

Finance

- Value chain members are reliant on non-bank financial support, such as from a parent company, majority shareholder and/or subsidies, creating a significant disadvantage for PIC value chain members. Alternatively, trips are often pre-funded by traders.
- Harvesters find it particularly difficult to secure finance as banks require land-based security, meaning that financiers place minimal extended value on vessels as security.

Training

- Limited competency-based training for deck crew available from local institutions, resulting in a high reliance on crew from overseas (e.g., Philippines, Indonesia), many of whom are long-serving. Senior management is typically comprised of expatriates and there is a lack of career paths for the local workforce.
- The National Fisheries College (NFC) in PNG and Fiji Maritime Academy provide the most comprehensive training programs in the Pacific, with most other training institutions lacking fisheries sector-specific training.
- Other training areas that could be developed further include food safety.

Infrastructure and related services

- Includes net yards, slipways and ports, repairs and maintenance.
- Limited infrastructure, facilities and expertise in the Pacific region. Parts are expensive given that they need to be imported in, often via other countries enroute.
- Vessels are often sent overseas to be serviced at better facilities, even if a Pacific port could handle the work.

Key insights

VALUE CHAIN ANALYSIS

The learnings from COVID provides an opportunity to identify critical success factors for tuna sector businesses, enabling comparison of value chain segments and different countries to identify key themes. Three critical success factors emerged from this analysis:

1. Integration

Businesses that concentrate on a single value chain function have found it increasingly challenging to compete in the global tuna sector – a challenge that is not specific to the Pacific region.

2. Diversification

Diversification is of particular importance in the longlining segment, where businesses are having to compete with heavily diversified conglomerates with multiple revenue streams.

Market diversification also proved to be important during COVID with the Fiji tuna sector hardest hit given its reliance on the US market and domestic tourist trade for fresh longline catch. In contrast, domestic demand in Solomon Islands and PNG for canned tuna helped to alleviate external shocks. Diversification will become increasingly important as the regulatory environment becomes more complex.

3. Scale

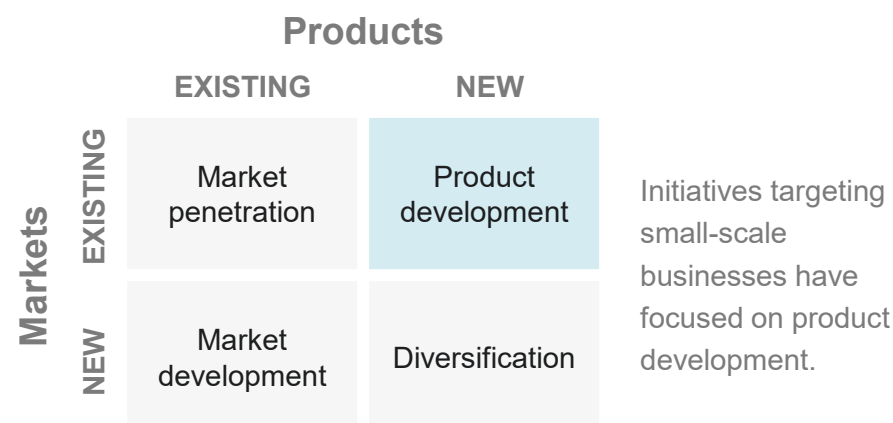
The Pacific's high-cost operating environment, particularly for logistics, power and water, means that scale is vital in order to achieve profitability. This is even more important for harvesters where

significant costs are involved in owning a fleet of vessels, even when operating below capacity. Standardisation of vessels, gears and engines is one way to optimise fleet servicing.

OTHER INITIATIVES

There have been numerous initiatives over the past few decades to improve the value from tuna resources. This has resulted in innovative approaches to access rights, such as the rebate scheme in PNG to encourage onshore processing and the Parties to the Nauru Agreement's (PNA) Vessel Day Scheme for access.

Other initiatives, particularly those targeting small-scale businesses, typically focus on product development and have had less success. The key challenge appears to be the high-cost operating environment and lack of local capability, exacerbated by a dispersed and remote population, creating significant barriers for commercial ventures to achieving financial sustainability. Furthermore, initiatives focused on by-catch struggle without a steady supply of tuna and lack of onshore cold stores capable of taking commercial volumes.



04

INCLUSIVE INNOVATION PATHWAY OPPORTUNITIES

- > **Approach**
- > **OPPORTUNITY 1**
Health and wellness inputs
- > **OPPORTUNITY 2**
Fish meal, aqua and animal feed
- > **OPPORTUNITY 3**
Cold chain development
- > **OPPORTUNITY 4**
Attracting and retaining local talent
- > **OPPORTUNITY 5**
Collective approach for small businesses
- > **Looking to the horizon**

Approach

The focus for this project was to identify opportunities for improving value retention and waste reduction for the Pacific tuna sector.

The following steps were taken to develop the recommended opportunities:

- Literature review to understand the spectrum of primary and end uses of tuna parts.
- Key informant interviews and literature review to develop an understanding of the Pacific tuna value chain, identifying key constraints, critical success factors and points of value add and/or waste.
- Drawing from the above two points and an additional review of literature, development of a long list of potential opportunities assessed against a set of criteria (see right panel), which was further refined to a short list of recommended opportunities.

Assessment criteria

1 Alignment and impact

Alignment with socio-cultural values, influences, systems.

Alignment with key strategies/priorities – PIC governments, Regional Roadmap for Sustainable Pacific Fisheries and ACIAR objectives.

For opportunities relating to systemic enablers – scale of impact on improving the enabling environment.

2 Technical feasibility

Gap between the current and required level of maturity in the Pacific region with respect to technology, infrastructure and skills/capability.

3 Commercial viability

Working capital requirements.

Prioritised opportunities that have the following characteristics: Low power and water usage; proximate to fish supply and end markets; available and willing labour.

4 Customer desirability

Potential/Target markets – Size of the market; are there enough potential customers to achieve profitability/scale?

Customer needs – Does the product/service solve a problem/deliver on a need for a customer and is it the right timing for market entry?

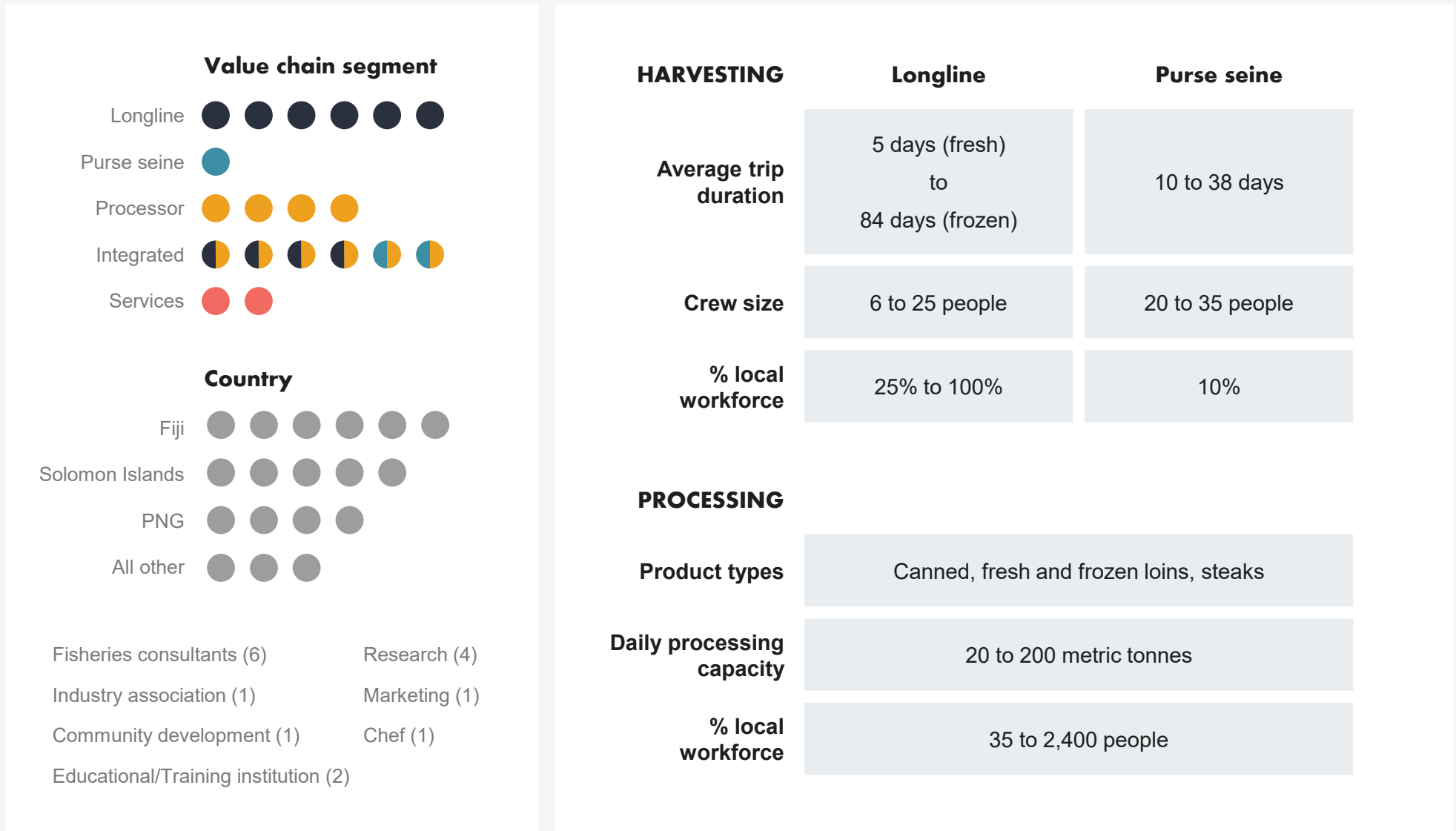
Pacific region's level of competitive advantage.

5 Other

Prioritised opportunities: Sufficient potential in the Pacific market alone; product contains a relatively low % of tuna; shelf stable; high value/low volume; aligned with macro trends such as environmental, social and governance (ESG) and increased health consciousness by Pacific Islanders.

De-prioritised opportunities: Involves significant/complex infrastructure given the challenging operating environment, rising sea levels and cyclone risk; requires relocation of workers.

Key informant breakdown



Each count refers to an organisation; multiple people from the one organisation may have been interviewed.

Given the relatively low number of Pacific tuna sector companies, value chain segment and country have not been consolidated (e.g., Fiji longline company) to maintain the anonymity of key informants.

STAGE 1**Long list of opportunities**

Given the Pacific's inherent constraints, the approach was to be **pragmatic** regarding the product/service being considered but **innovative** with respect to how it could be delivered.

Each opportunity was given an overall rating based on the [assessment criteria](#). Opportunities that progressed to Stage 2 are indicated in **bold**. Please refer to [Appendix 5](#) for brief descriptions of the opportunities that did not progress to Stage 2.

The following **enablers** were also considered in Stage 2:

- Cold chain development.
- Attracting and retaining local talent.
- Collective approach for small businesses.

Opportunity	Alignment	Feasibility	Viability	Desirability	Other	Overall
Health and wellness inputs ●	■	■	■	■	■	★★★★
Fertiliser ¹ ●	■	■	■	■	■	★★★★
Fish meal, aqua and animal feed ●	■	■	■	■	■	★★★★
Smoked tuna ●	■	■	■	■	■	★★★★
Tuna jerky ●	■	■	■	■	■	★★★★
Nutritious convenience foods ●	■	■	■	■	■	★★★★
School lunches ●	■	■	■	■	■	★★★★
Micro-canneries ●	■	■	■	■	■	★★★
Bottled tuna ●	■	■	■	■	■	★★★
Fish silage ●	■	■	■	■	■	★★★
Water reclaiming from processing ² ●	■	■	■	■	■	★★★
Integrated seafood restaurant ●	■	■	■	■	■	★★★
Tuna essence ●	■	■	■	■	■	★★★
Pharmaceutical inputs ●	■	■	■	■	■	★★★
Green methanol fuel ●	■	■	■	■	■	★★★
Biodiesel from tuna waste ●	■	■	■	■	■	★★
Reuse of old fishing gear/nets ●	■	■	■	■	■	★★
Pet food ●	■	■	■	■	■	★★
Leather ●	■	■	■	■	■	★★
Biodegradable plastic ●	■	■	■	■	■	★★
Waste oil from fishing vessels ●	■	■	■	■	■	★★
Aquaculture ●	■	■	■	■	■	★★






● Food ● Feed ● Industrial ● Biomedical ● Other

Lowest value Highest value

¹ Fertiliser was subsequently cut from the short list given its low value.

² Although water reclaiming from processing was not short-listed for further analysis, technology to reclaim water from processing operations is becoming increasingly affordable. Further details have been included in [Appendix 6](#).

STAGE 2: Short-listed opportunities

 Health and wellness inputs	 Fish meal, aqua and animal feed	 Cold chain development	 Attracting and retaining local talent	 Collective approach for small businesses
<p>Creating intermediate products such as protein and collagen as inputs for health and wellness products.</p>	<p>Creating fish meal, aqua and animal feed to support the Pacific local food system.</p>	<p>Developing cold chain logistics and infrastructure to enable product innovation.</p>	<p>Raising awareness of fisheries sector careers and future-proofing the Pacific fisheries training network.</p>	<p>Collectivising small businesses to help achieve the critical success factors of integration, diversification and scale.</p>
<p>Inputs: Processor waste and other waste post-processing.</p>	<p>Inputs: Processor and harvester waste.</p>	<p>Enables: Broader talent pipeline and regionalised training.</p>	<p>Enables: Broader talent pipeline and regionalised training.</p>	<p>Enables: Shared knowledge and innovation; improved access to finance and markets.</p>
<p>Target market: Global health and wellness sector.</p>	<p>Target market: Local growers in the Pacific region.</p>	<p>Outcome: Key barrier to product innovation has been addressed.</p>	<p>Outcome: Improved recruitment and retention of the local workforce; sector's status enhanced as a career of choice.</p>	<p>Outcome: Improved the enabling environment for small businesses.</p>
<p>Alignment with key priority areas: Sustainability, value retention, food and nutritional security.</p>	<p>Alignment with key priority areas: Sustainability, value retention, food and nutritional security, employment.</p>	<p>Alignment with key priority areas: Value retention, food and nutritional security.</p>	<p>Alignment with key priority areas: Employment, capacity building.</p>	<p>Alignment with key priority areas: Inclusive value chains, capacity building.</p>

Refer [Appendix 2](#) for key priority areas.

**“Let’s push forward
together as we transform
the world’s food systems**

**H.E. Amina J. Mohammed, Deputy
Secretary-General, United Nations**

The Pacific food system is under increasing pressure to transform, and with transformation comes opportunity. Opportunities in this section explore the role that tuna can play in transforming Pacific food systems and beyond.

PRODUCTS

At present, tuna processing waste is used for by-products by PIC processors, albeit in limited volumes.

Fish meal and fish oil are the primary by-products, with heads sold into the local market without further processing.

There is an opportunity to improve the quality of current by-products and move into higher value by-products, with health and wellness inputs, and aqua and animal feed recommended in this report.

There are commonalities in processing steps across the various product streams, demonstrating the potential for investments to benefit multiple product options.

Process	Health and wellness inputs				Fish meal, aqua and animal feed		
	Hydrolysed protein	Collagen	Bioactive peptides	Omega-3 oils	Fish meal	Tailored aqua/ animal feeds	Animal feed supplementation
Raw material selection	Light	Light	Light	Light	Dark	Dark	Dark
Cooking	Light	Light	Light	Light	Dark	Dark	Dark
Grinding	Light	Light	Light	Light	Dark	Dark	Dark
Pressing	Light	Light	Light	Light	Dark	Dark	Dark
Homogenisation	Light	Light	Light	Light	Dark	Dark	Dark
Balance pH	Light	Light	Light	Light	Dark	Dark	Dark
Enzyme introduction	Light	Light	Light	Light	Dark	Dark	Dark
Hydrolysis	Light	Light	Light	Light	Dark	Dark	Dark
Enzyme inactivation	Light	Light	Light	Light	Dark	Dark	Dark
Cooling	Light	Light	Light	Light	Dark	Dark	Dark
Centrifugation	Light	Light	Light	Light	Dark	Dark	Dark
Supercritical CO ₂ extraction	Light	Light	Light	Light	Dark	Dark	Dark
Drying	Light	Light	Light	Light	Dark	Dark	Dark
Milling	Light	Light	Light	Light	Dark	Dark	Dark
Pellet extruding	Light	Light	Light	Light	Dark	Dark	Dark
Packaging	Light	Light	Light	Light	Dark	Dark	Dark



OPPORTUNITY 1

Health and wellness inputs

Tuna processing waste offers an excellent raw material source for health and wellness products. The inputs for these are readily created by a simple enzyme digestion process that results in fish protein hydrolysate, and with some care, collagen or bioactive peptides.

Fish protein hydrolysates, collagens and bioactive peptides have been shown to provide a wide range of benefits for human health and are increasingly sought by food manufacturers, nutraceutical, pharmaceutical and cosmeceutical companies.

Key challenges in developing these high-value products will be achieving preferred supplier status for functional or fortified food manufacturers, controlling processing parameters for each type of product and maintaining consistent quality.

NOW



Up to 60 per cent of tuna body weight is typically regarded as waste.

There is currently high demand for components of this waste material.

NEXT



Valorise tuna processing waste into hydrolysed protein powder. This is a valuable input to fortified and functional foods and can be processed from waste with simple equipment and skill needs.

FUTURE



Increasing the value of tuna by-products by extracting specific functional compounds such as collagen or bioactive peptides. Refined products command a higher price and minimal further equipment investment is required.

Value chain: Health and wellness inputs

NOW

Tuna processing waste

Parameters determined by end product

Enzyme hydrolysis

Hydrolysate

Fish oils

Hydrolysed Protein

Collagen

Bioactive Peptides

Omega-3 Oils

Food Manufacturers

- fortified foods
- functional foods
- specialised foods

Nutraceutical Industry

- health promotion
- exercise recovery

Pharmaceutical Industry

- controlled drug release
- wound healing
- biomedical scaffolds

Cosmeceutical Industry

- ageing prevention
- beauty enhancing

NEXT

Refer [Appendix 7](#) for the detailed hydrolysate protein production process.

FUTURE

Getting from Now to Next, and Future

NEXT

Extracting health and wellness products from tuna provides opportunity for greater revenue gain from low-value waste material. The greatest value addition occurs when using fish waste for extracting proteins, for example, tuna trimmings, heads, frames, skin and fins, as well as waste from other seafood processed and low-value harvest by-catch.

Ensuring there is a reliable and adequate supply of raw material is essential as production of 1 metric tonne of fish protein hydrolysate requires 4-5 metric tonnes of raw material.

Production of hydrolysed protein is a straight-forward enzyme digestion process to separate proteins from fish skeletal structures and break down proteins into a range of smaller protein components. There is relatively low capital investment required, with the key cost driver being the processing system used (batch versus continuous processing), which is dictated by throughput volume.

Key requirements

- Minimal specialised infrastructure and uncomplicated equipment:
 - cooking system for raw waste material
 - enzyme hydrolysis tank
 - centrifuge for separation of solid from liquid fractions
 - dryer to remove remaining water
 - mill to create hydrolysate powder
- Routine machinery operation skills, following good manufacturing process (GMP) and process control (HACCP) monitoring.

FUTURE

To move into higher value products that are in demand as inputs to the pharmaceutical and cosmeceutical industries, there is little extra capital investment required but more reliance on staff capabilities and external providers.

Altering the processing parameters to create commercially viable yields of collagen or bioactive peptides requires research to determine the specific parameters appropriate for the raw material available and achieve high yield of specific end products sought by markets.

External providers are needed to establish the quality of the products created to ensure they meet stringent customer specifications.

Key requirements

- Knowledge of the processing parameters needed for specific end products.
- Processing quality control monitoring equipment.
- A proven ability to create high quality hydrolysates to meet specific customers' needs.
- Extra levels of certification may be required to supply to certain industries (e.g., ISO 22000, Pharmacopoeia Standards).

Next steps

BUSINESS CASE ASSESSMENT

A business case will need to be completed to determine the commercial viability of this opportunity and assist with gauging private sector interest.

RESEARCH BIOACTIVITY OF PEPTIDES

While there is a large body of information on bioactive peptides found in tuna waste, the research has often been specific to particular components of the fish, for example heart muscle or eyeballs and not necessarily the specific species processed in the Pacific region.

Additionally, most reports are laboratory investigations and need to be confirmed within the context of commercial up-scaling.

Research is needed to confirm the bioactivity of peptides present in the hydrolysed tuna waste from fish harvested in the Pacific Islands to identify compounds present and their activities.

VERIFY PROCESSING PARAMETERS

Many studies have demonstrated how changes in the key processing parameters (enzyme used, temperature and duration of digestion) alter the resulting yields of protein, collagen, bioactive peptides, and oils.

Research is required on Pacific Island tuna to quantify specific bioactive yields and establish the processing parameters most effective for yields of different compounds.

Research is also required to understand the effect on nutritional component profiles of different batches of waste material used throughout harvest season.

EQUIPMENT AND MATERIAL SOURCING

The equipment used for hydrolysing tuna proteins is similar to that used by many other food manufacturing processes, so there may already be local suppliers or manufacturers. Identifying where to source, and who will maintain the equipment is an important part of working out the viability of this opportunity.

In the same way there is a need to identify suppliers for enzymes, chemicals and other inputs needed (such as packaging).

DEVELOP POTENTIAL CUSTOMER RELATIONSHIPS

One of the most important next steps is to establish and begin to develop relationships with potential customers in the global food, nutraceutical, pharmaceutical and cosmeceutical industries.

These customers will clarify quality and volume requirements and standards that must be met. Setting up offtake agreements in advance of establishing a plant will help with securing funding for the venture.

A similar process to the one outlined in this section ('Next steps') has recently been undertaken for '100% Whitefish' as part of the Iceland Ocean Cluster and could be used as guidance¹.

¹ Leeper (2023)

Health and wellness input opportunities

HYDROLYSED PROTEIN

Hydrolysis uses a simple enzyme digestion process to break down large proteins into smaller protein chains and peptides. These smaller components are easily absorbed and can better support sports and health outcomes.

Fish protein is the protein source of choice, as fish proteins:

- are nutritionally rich with abundant, well-balanced amino acid content
- high in essential amino acids – especially methionine, lysine, tryptophan phenylalanine compared to plant protein
- have high digestibility, providing more efficient rates of intestinal absorption

These characteristics trigger strong demand for fish protein for use in functional food and for creating fortified foods directed towards health and wellness. Local and international food manufacturers are likely customers.

Running the process with specific digestion conditions allows production of selected end-product proteins. By-products of the hydrolysis is tuna oil, high in omega-3 fatty acids and bone material, a useful mineral source.

The commercial value of protein-based products was estimated to be US\$267 billion in 2021¹.

COLLAGEN

Running the protein hydrolysing process with a collagenase enzyme and the right hydrolysis conditions can provide a much higher yield of collagen proteins in the end product.

Collagen is a major structural component of the human body that is lost with age and it plays a pivotal role in tissue development. Fish collagen is a popular source of collagen and is used in many health and wellness products to promote plump skin, muscle repair and ligament integrity. Fish collagen is particularly growing in use in the cosmetic industry as a moisturiser and natural humectant.

Fish collagen is also suitable for markets where bovine and porcine sources of collagen are not an option due to cultural or religious beliefs.

Biomedical uses for collagen include scaffolding for tissue engineering and wound healing. Pharmaceutical uses include gelatin capsules for controlled drug delivery. Fish gelatin is also increasingly used in food manufacture.

The market for collagen products in 2022 was US\$9.1 billion and is expected to grow at a compound annual growth rate of 10.2 per cent annually².

¹ Das, Nayak & Dash (2021)

² Grandview Research (n.d.-a)

Health and wellness input opportunities

BIOACTIVE PEPTIDES

Running the protein hydrolysing process with specific parts of the tuna, the right enzymes and the right hydrolysis conditions can provide a much higher yield of bioactive peptides in the end product. Bioactive peptides derived from tuna can provide a range of health benefits, which has been the focus of developments in nutraceuticals and functional foods.

Research is focusing on the diverse range of beneficial activities different bioactive peptides provide. Those derived from tuna have already been shown to have anti-oxidant, anti-microbial, anti-inflammatory, anti-aging properties, and can act as biochemical scavengers. In cosmetics, elastin peptides have been shown to help skin elasticity and reduce wrinkles.

The market for bioactive peptides in 2020 was valued at US\$48.62 billion and is projected to reach US\$95.71 billion by 2028, growing at a compound annual growth rate of 8.86 per cent¹.

OMEGA-3 OILS

A by-product from the hydrolysis process is tuna oil and this is readily refined using a supercritical CO₂ fluid extraction method to achieve highest yield and end-product quality.

Fish oils, like that from tuna, are high in the omega-3 fatty acids which can help prevent coronary heart diseases, high blood pressure, inflammation, and excessive triglycerides (blood fats). With omega-6 oils being more common in a modern diet, supplementation with omega-3 fish oils is increasingly recommended.

There is also an increasing focus on dermatological uses for omega-3 fish oils in treating skin and scalp conditions which is expected to lead to a growth in demand.

The market for omega-3 fish oils in 2022 was US\$2.43 billion and is expected to grow at a compound annual growth rate of 7.8 per cent annually².

¹ Verified Market Research (2022)

² Grandview Research (n.d.-b)

OPPORTUNITY 2

Fish meal, aqua and animal feed

Food production from aquaculture is growing at a rapid rate and predicted to continue this trend as a sustainable production system for marine and freshwater food proteins. Fish meal is an important component of aquaculture feeds due to the high bioavailability of nutrients for fish and crustacea, and is also incorporated into animal feeds, particularly poultry and porcine. This is creating an increasing demand for fish meal.

Several Pacific Island tuna processors are already producing small volumes of fish meal from processing waste. There is the opportunity to expand and coordinate this activity to provide high-quality and consistent volumes of fish meal for use as a key ingredient to develop local animal feeds.

There is also an opportunity for development of a commercial aquafeed production plant to provide local aquaculture ventures with cost-effective feed, supporting and underpinning the viability of future industry growth.

Key challenges will be distribution costs, quality control, and consistency of supply.

NOW



Non-retailed components of tuna are seen as waste or sold as is without adding value.

Waste processing costs money but there are opportunities to valorise it as animal feeds.

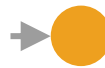
NEXT



Valorise tuna processing waste into fish meal.

Low equipment and skill requirements, demand across Pacific Islands, underpins aquaculture development

FUTURE



Increasing value of tuna by-products by creating tailored aqua/animal feeds.

Modest increase in equipment needs, greater value to local aquaculturists.

Identifying local feed ingredients and demonstrating benefits of resulting feeds for local species.

Value chain: Fish meal, aqua and animal feed

NOW

Tuna processing waste

NEXT

Cooking, pressing, and grinding

Fish oils

Fish meal

Ingredient

Refer [Appendix 7](#) for the detailed fish meal production process.

FUTURE

Add other ingredients to fish meal
(starch, fibre, oils) to create feed

Aquafeed

Animal feed

Omega-3 Oils

Animal Feed Supplements

Domestic Markets

- increased farm yields
- healthier fish / animals
- import replacement

Export Markets

- increased farm yields
- healthier fish / animals
- export earnings

Getting from Now to Next, and Future

NEXT

Processing of seafood for retail food supply generates 60-70 per cent waste material and this is often discarded. Using seafood processing waste as raw material for fish meal production provides compelling benefits of gaining additional value from the harvested fish, utilising a waste stream and minimising environmental impact, as well as reducing pressure on diminishing fish stocks.

Production of high-quality fish meal creates the opportunity to supply product ingredient into locally based animal feed or aquafeed ventures.

There is a relatively low capital investment required, with the key cost being processing volume and batch versus continuous processing.

Key requirements

- Minimal specialised infrastructure and uncomplicated equipment:
 - cooking system for raw waste material
 - press system for separation of water, solids and oils
 - dryer
 - grinder
 - packager suitable for the end fish meal product
- Routine machinery operation skills and following GMP.

FUTURE

One of the key constraints to growth in Pacific Island aquaculture has been the variable quality and limited availability of feeds, with a reliance on expensive imported feeds. The cost of feed is the major expense in intensive aquaculture, around 60 per cent of production costs, and hence feeds must be cost effective for continued venture success.

To successfully realise the potential for aquaculture within the Pacific Islands, there is a significant need for a locally produced affordable aquafeed to replace the expensive imported feeds. This could be met by taking the processing of fish meal further, adding other ingredients (starches and oils), and creating pelletised aquafeeds that either float or sink.

Key requirements

- The main extra equipment needed is a mixer and pellet extruder to create the end product feed.
- Feed formulation is often specific to the species for which the feed is being made. Information needed to formulate diets includes nutritional requirements, digestibility, pellet size and buoyancy.
- Maintaining the technical parameters during processing to ensure optimal feed quality and nutrient value.

Fish meal, aqua and animal feed opportunities

FISH MEAL

Fish meal is a dried granular powder produced from whole fish or unused portions generated from processing fish for retail food market. It is a nutrient-rich source of high-quality protein, essential amino acids, phospholipids, minerals and some vitamins.

There is an existing world-wide shortage of fish meal and alternative protein sources, such as plant proteins, are being explored. However, fish meal delivers a range of readily digestible nutrients most similar to the natural diet of aquacultured species, which plant proteins cannot readily provide.

Production of high-quality fish meal creates the opportunity to supply the main ingredient for animal feed production ventures. Fish meal is produced through a simple wet-reduction process to remove water content from the waste material followed by drying and grinding. This process requires minimal specialised infrastructure and uncomplicated equipment.

A limited volume of fish meal is being produced locally in PNG, Solomon Islands, Marshall Islands and Fiji, although not always of consistent high quality. The tuna bloodline is typically canned so the fish meal is high in bone ash and low in protein.

TAILORED AQUA/ANIMAL FEEDS

There is substantial potential in the Pacific Islands to develop aquaculture ventures for producing an alternative source of food protein. One of the identified key constraints to growth in Pacific Island aquaculture enterprise has been variable quality and limited availability of feeds. The cost of feed is the major expense in aquaculture. To successfully realise the potential for aquaculture within the Pacific Islands there is a need for high quality, affordable, locally produced, aquafeed to replace the expensive imported feeds.

Feed formulation is often specific to cultured species for which the feed is being made. Feed ingredients that may be able to be sourced locally include raw fish, fish meal, fish oil, mill mix bran, coconut meal, rice pollard, cassava, and wheat flour.

Fish meal, aqua and animal feed opportunities

ANIMAL FEED SUPPLEMENTATION

Just as humans can benefit from supplementation that brings increased health benefits, so can animals. This can increase growth rates, disease resistance and improve the quality of the end products of the animals.

Processing is similar to that required for creating bioactive peptides for human consumption. A compelling example of benefits is increasing the disease resistance of juvenile barramundi being raised on aquaculture farms¹.

OMEGA-3 OILS

A by-product from the pressing process is tuna oil, high in omega-3 fatty acids. It is increasingly common to see supercritical CO₂ fluid extraction used to extract a high quality and yield of fish oils.

Fish oils, like that from tuna, are a useful supplement in creating tailored aquafeeds. While this is likely to be a less valuable market than creating human fish oil supplements, it also has less stringent quality requirements.

¹ Siddik et al. (2021)

Next Steps

BUSINESS CASE ASSESSMENT

A business case will need to be completed to determine the commercial viability of this opportunity and assist with gauging private sector interest.

IDENTIFY FEED RECIPES

Aquafeed and animal feed need to be created with specific species' nutritional needs in mind to maximise benefits to farmers. Current demand for aquafeed in the Pacific Islands relates to tilapia and giant freshwater prawn (*Macrobrachium Rosenbergii*), with some barramundi in PNG¹. Carp and trout aquaculture is in its early stages, which may lead to increased feed demand for these species in the future.

Research is required to identify feed formulations suited to the needs of the target market (domestic or export), using local ingredients where possible and accounting for factors such as certain species needing a higher percentage of protein. Local ingredients could include coconut (oil cake or meal), tapioca (flour), or cassava (flour, leaves)². The preferred processing method (milled, cooked, etc.) also needs to be determined.

DESIGN FOR SCALE

Small-scale production may be desirable in the short term as a proof of concept; however, continuous processing at scale is required to achieve long-term commercial sustainability, which in turn requires a consistent supply of inputs.

Scalability should be a key determinant of the business model for a feed production enterprise in the Pacific. One example is a joint venture between several tuna processors in relative proximity to each other, to achieve scale, improve consistency of input supply and reduce costs.

EQUIPMENT AND MATERIAL SOURCING

Equipment used for producing fish meal and animal feed is similar to equipment used in many other food manufacturing processes, so there may already be local suppliers or manufacturers. Identifying where to source, and who will maintain the equipment is an important part of determining the viability of this opportunity.

AQUAFEED SUPPLY CHAIN RELATIONSHIPS

Aquaculture in the Pacific Islands suffered during COVID and in many countries it is still nascent. Where well established in the Pacific region, feed is typically imported at high cost from Vietnam and elsewhere.

Any new aquafeed venture should establish both supplier and customer relationships along the supply chain as there is the potential for both export to other Pacific Islands and significant local market opportunities. Monopoly of either supply or demand is best to avoid and so tilapia might be one of the best species to target as it is so prevalent across the Pacific region.

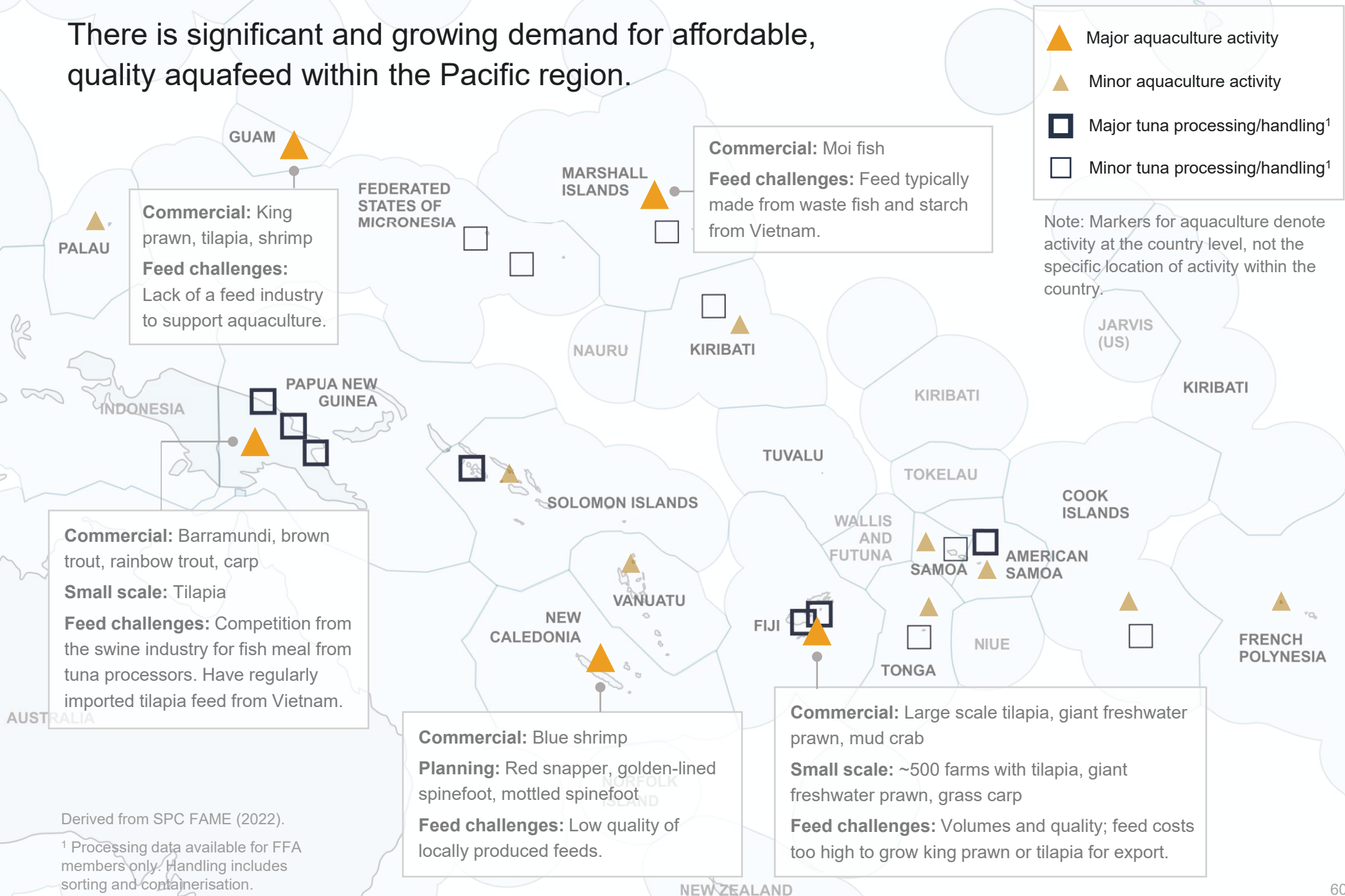
PILOT PROJECTS

Where aquafeeds are formulated and trialled locally it is important to establish reliability of raw material supply, thereby ensuring availability of aquafeed. Diets developed for Pacific Island aquacultured species need to be trialled for animal growth rate efficacy.

¹ SPC Fame (2022)

² FAO (n.d.-a), FAO (n.d.-b), FAO (n.d.-c)

There is significant and growing demand for affordable, quality aquafeed within the Pacific region.



Derived from SPC FAME (2022).

¹ Processing data available for FFA members only. Handling includes sorting and containerisation.

“What if we thought of the ocean as something that connects rather than isolates?”

Andrew Faávale, ManaWise Group

The ‘Blue Pacific narrative’ was first introduced in 2017 by the Pacific Islands Forum Secretariat, representing a united identity and collective vision for the region where the Pacific Ocean is not just a geographic feature, but a cultural and spiritual way of connecting the people of the Pacific region. Opportunities presented in this section lean into the Blue Pacific mindset of regional collaboration.

ENABLERS

OPPORTUNITY 3

Cold chain development

One of the key constraints to growth of the Pacific tuna sector and tuna product innovation is cold chain logistics and infrastructure. Investment in the Pacific's cold chain would unlock greater opportunities not just for the tuna sector, but the food sector more broadly, contributing towards food security and economic growth.

Cold chain logistics and infrastructure will be required for product innovations that require aggregation of tuna waste to produce food and feed products, to limit deterioration of tuna waste during transport and in storage (e.g., Opportunities 1 and 2). Cold chain innovations will also improve market access for the Pacific tuna sector, with emerging technology potentially enabling frozen tuna to be substituted for fresh tuna.

NOW



Cold chain logistics and infrastructure being developed in countries such as Papua New Guinea; however, limited options in smaller, more remote PICs.

NEXT



Sufficient advancements in cold chain logistics and infrastructure to support the commercial feasibility of value-added opportunities for tuna waste.

FUTURE



Technological advancements in cold chain logistics and infrastructure enable remote PICs to participate in value-adding opportunities for tuna, including smaller businesses focused on the domestic market.

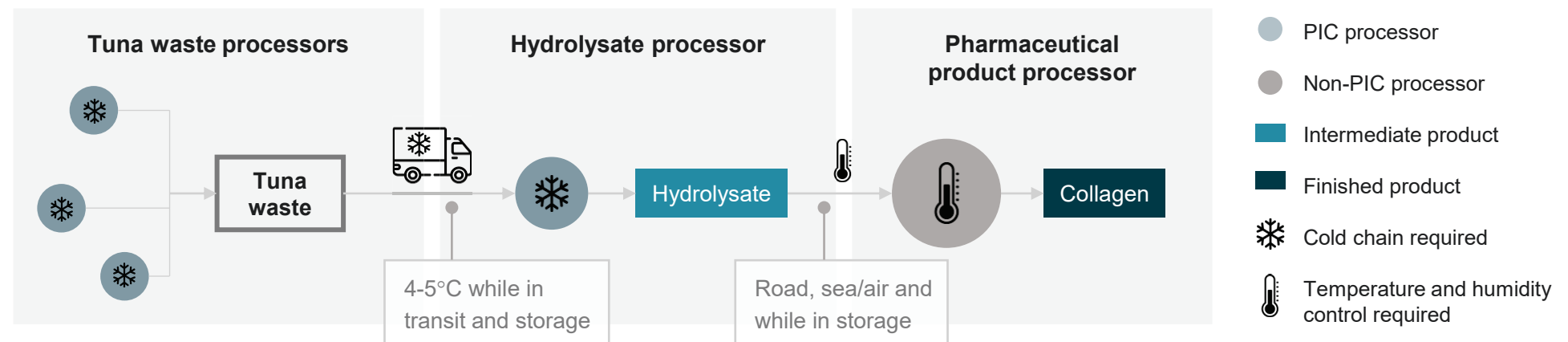
Current state

- Cold chain has historically been an underdeveloped area for PICs although COVID prompted the development of cold chain logistics and infrastructure for medical purposes (e.g., vaccines).
- Papua New Guinea has the most advanced cold chain logistics and infrastructure with recent developments in fresh produce supply chains. One example is the Kundiawa-Gembogl District Development Authority Agrotech Produce warehouse in Port Moresby, which has a warehouse with refrigerated systems and has enabled fresh produce transport in refrigerated trucks¹ to the nearby provinces.
- In contrast a lack of cold storage facilities is a challenge in other PICs, exacerbated by high costs of power. A recent International Finance Corporation report identified a lack of cold storage facilities as a key gap in Fiji's agri-logistics sector².
- Regarding the tuna sector, access to markets such as Japan have traditionally been reliant on fresh tuna transported by air freight.

FIGURE 21

Cold chain requirements

Example provided for hydrolysate production; similar requirements for other tuna waste product innovations.



¹ Nangoi (2022)

² International Finance Corporation (2022)

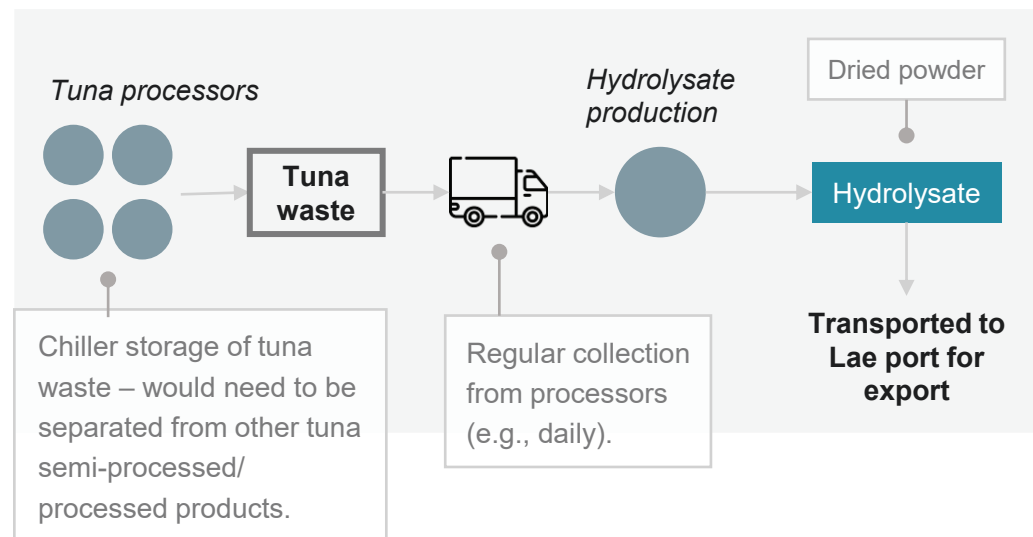
Next steps

- Food security and self-sufficiency is a key priority for the Pacific region. An increased focus across the region on local production of fresh produce highlights the growing importance of improving the Pacific's cold chain logistics and infrastructure. As such, a gap analysis of current state versus forecast needs is recommended to identify investment priorities.
- Furthermore, opportunities for product innovation identified in this report will require cold chain logistics and infrastructure to minimise deterioration of tuna waste. Cold chain requirements should be included as part of the next steps for Opportunities 1 and 2 (i.e., feasibility studies). Figure 22 is an example of how cold chain management costs could be minimised.

FIGURE 22

Example hydrolysate production set-up: Lae, PNG

There are four tuna processors in Lae that are likely able to supply sufficient tuna waste volume for a hydrolysate production facility to be commercially viable.



- In the Pacific tuna sector there are two ways that innovations could open new strategic possibilities for fresh tuna typically air freighted to international markets, i.e., the segment that experienced the greatest impact from COVID disruptions.
- The Japanese market has shown a willingness to replace fresh tuna with ULT frozen tuna at -40°C to -60°C . Upgrading boat, dock and processing cold chains to use ULT may allow more product to be shipped and at lower cost.
- Emerging technology from [EverCase](#) enables food to be supercooled so that it can be refrigerated at -12°C without developing ice crystals. Fresh tuna transported from vessels at 0 to 1°C can be slowly supercooled to -12°C . This would stop enzyme, bacterial and viral activity whilst using less power than ULT and allow fresh tuna to be delivered via sea freight. EverCase would have to be able to provide devices suitable for fresh tuna boxes at a price that significantly decreases the overall transport cost.

OPPORTUNITY 4

Attracting and retaining local talent

Localisation of workforces in the Pacific tuna sector remains relatively low, particularly in commercial fishing operations, foreign-owned businesses and at more senior levels.

Reasons cited include:

- Varying availability of fishing-specific training in the region (e.g., boat handling, equipment use), although trained Pacific people are not necessarily valued any more than untrained. Foreign-owned businesses are particularly unwilling to invest in training.
- Lack of opportunities as vessels have existing crews and/or would prefer to hire from Asia through an agency.
- Limited resources on the ground to coordinate training.
- Tough working conditions and alternative job opportunities means there is less interest from young people to replace those aging out of the workforce.
- Working conditions and employment arrangements do not necessarily align with cultural values and ways of life.
- General perception of tuna sector jobs as being sea based, not realising that most jobs are land based. Little visibility/awareness of the variety of jobs and career paths available.

NOW



Narrow perception of the tuna sector.

Training capability spread across the region.

Challenging working conditions.

NEXT



Improved awareness of the diverse range of careers available in the tuna sector.

Focused investment on regionalised service offerings.

Fair working conditions and career paths.

FUTURE



Tuna sector holds the status as a career of choice.

Centres of excellence at the forefront of sector training needs.

Fair working conditions.

The Pacific region is rapidly urbanising. Challenges with localisation of the Pacific tuna sector workforce will also evolve as a cash versus traditional economy becomes the norm.

For example, the tension between the requirements of a cash economy (e.g., regular working hours) and traditional ways of life should naturally ease as the urban versus rural population increases.

To improve localisation of the tuna sector workforce, structures need to be in place to both attract people to the sector and develop appropriately skilled employees, keeping up with advancements in skill requirements.

ATTRACT Awareness campaign

While the Pacific tuna sector has unique needs, parallels can be drawn from the seafood industries of other countries, as well as similarly tough working environments such as the defence force.

A targeted awareness campaign helping to broaden people's perspectives on the tuna sector and career opportunities.

RETAIN Regionalised training approach

The global tuna sector is becoming increasingly sophisticated, including advanced technology on vessels and the development of innovative tuna products and packaging. To remain viable/competitive while prioritising a local workforce, the Pacific region's training capabilities will need to keep pace with the evolving needs of the Pacific's tuna sector.

A training approach that mobilises training capability across the region.

RETAIN Improved working conditions

Poor working conditions is a key challenge that needs to be addressed to improve localisation of the tuna sector workforce. A separate project is already underway to address working conditions, the Labour Standards on Fishing Vessels Project¹, supporting adoption of the [Harmonised Minimum Terms and Conditions for Access by Fishing Vessels](#)². This recommendation has been included for the sake of completeness, given its critical role complementing the above two recommendations.

¹ Implemented by FFA, International Labour Organization, International Organization for Migration and United Nations Office on Drugs and Crime.

² Pacific Island Forum Fisheries Agency (2019)

ATTRACTING AND RETAINING LOCAL TALENT

Awareness campaign

The Pacific region's young population and challenges with migration overseas for more attractive job opportunities is making it increasingly difficult for the Pacific tuna sector to retain employees. For the sector to evolve and take advantage of opportunities producing higher value products, capability will need to be developed in the region, as well as a pipeline of talent.

Current state

- Many people associate fisheries with fishing, not realising that there are many other land-based job opportunities.
- Limited career progression opportunities. Particularly challenging for Pacific locals to advance to more senior positions.
- Jobs on vessels are very physically demanding and have a reputation for poor working conditions.
- High turnover for a range of reasons, including those cited above and competition with more attractive job opportunities overseas.
- Historically perceived as being a male-dominated industry despite the high proportion of women in processing.

Proposed approach

- Campaign to raise awareness about the possibilities in the fisheries sector, both encouraging existing talent to understand their opportunities to develop further within the sector and – for new workers – to consider the sector as a job option/career path.
- Although this will not address the underlying employment challenges of the sector, the aim is to attract a wider pool of talent and gradually improve the attractiveness of the sector, alongside initiatives such as the Harmonised Minimum Terms and Conditions for Access by Fishing Vessels.
- Print and digital media plus a showcase of 'hero' stories of people who have challenged the status quo (potentially online) – for example, one of NFD's vessel captains who was the first Pacific Islander to have reached a senior level on a vessel.
- Focus the print campaign on urban areas – more likely to reach our target audience (e.g., young people who have moved from rural areas into the city looking for a job).

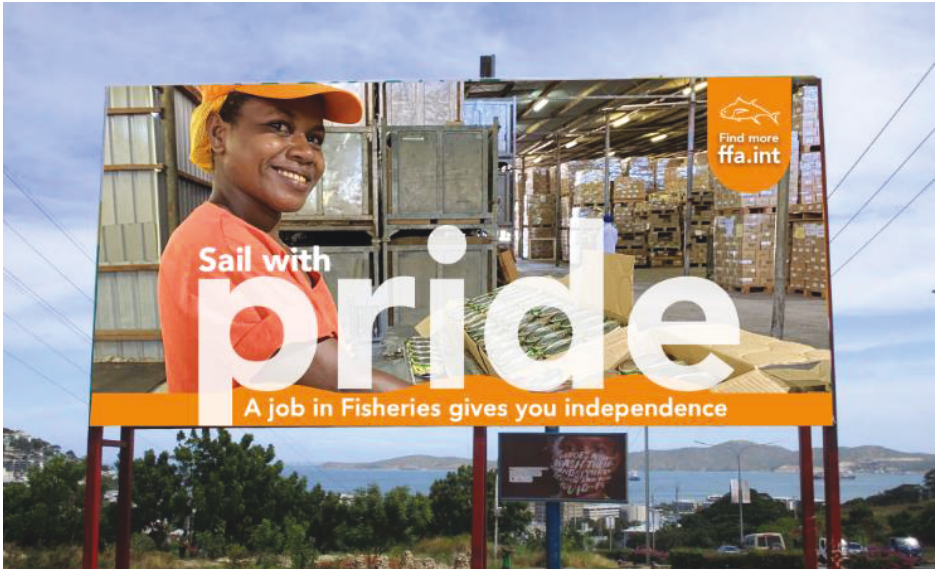
pride
future
dreams
growth
security
family
inclusivity

A range of messages highlighting key attributes of the tuna sector while broadening people's perspectives of the types of jobs available.



Please note all photography has been placed as concepts only (copyright SolTuna 2023)

04 INCLUSIVE INNOVATION PATHWAY OPPORTUNITIES:
ATTRACTING AND RETAINING LOCAL TALENT



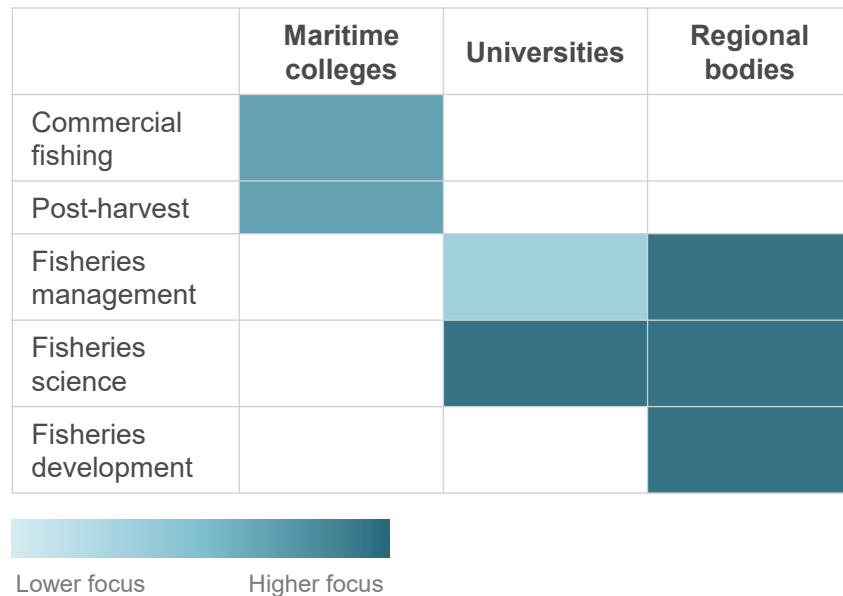
ATTRACTING AND RETAINING LOCAL TALENT

Regionalised training approach

The global tuna sector is becoming increasingly sophisticated, including advanced technology on vessels and the development of innovative tuna products and packaging. For the Pacific tuna sector to remain viable and competitive in the global market over the long term while prioritising a local workforce, the region’s training capabilities will need to keep pace with the evolving needs of the sector.

FIGURE 23

Summary of training focus areas



Current state

- Range of training and academic institutions across the region with varying areas of focus (refer Figure 23).
- Additional capability built through regional bodies such as the Pacific Community (SPC) and FFA.
- Limited coordination and collaboration across the region, mostly facilitated by FFA. Some level of regional support provided by SPC’s Educational Quality and Assessment Programme (EQAP).

Opportunity

- The University of the South Pacific is working towards positioning itself as a Centre of Excellence for the delivery of training and education in fisheries management¹, with assistance from the Pacific-European Union Marine Partnership Programme (PEUMP).
- Commercial fishing and post-harvest operations provide a greater opportunity for local employment, and therefore a similar Centre of Excellence approach could be established for these areas of the tuna sector, as well as the increasingly complex area of fisheries governance and compliance.
- The scope of the Centre of Excellence would span the region, enabling focused investment on, for example, new processing technologies with capability disseminated across other institutions in the region by the Centre of Excellence.

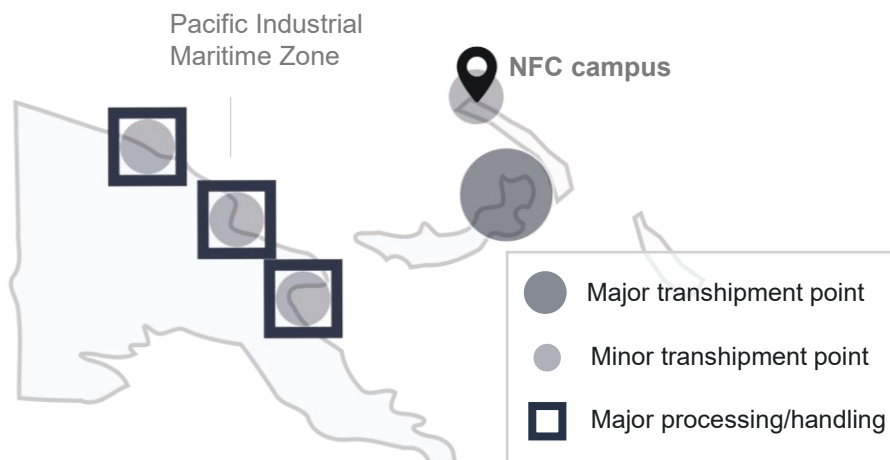
¹ Pacific-European Union Marine Partnership Programme (2019)

Proposed approach

Adoption and implementation of the Harmonised Minimum Terms and Conditions for Access by Fishing Vessels is expected to increase demand for training under the labour component, and the introduction of new processing technologies, such as pouching, is already highlighting the lack of training expertise in the region.

PNG's National Fisheries College (NFC) has a comprehensive, competency based, and industry aligned curriculum, which includes commercial fishing and post-harvest operations. All courses delivered at NFC:

- meet Australian and New Zealand Standards;
- comply with PNG's National Training Council's Qualifications Framework; and
- comply with the requirements of the Department of Higher Education, Research, Science and Technology (DHERST).



The following are key constraints to NFC's growth:

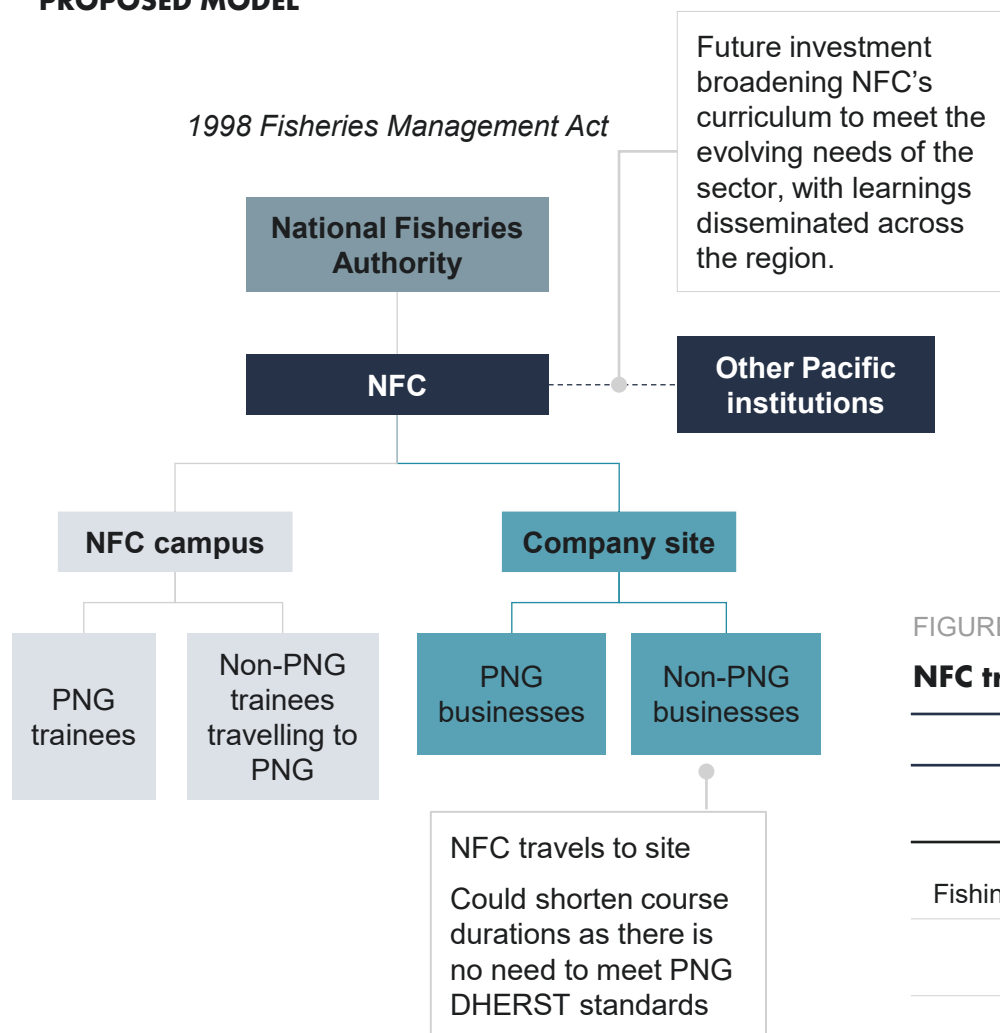
- Under DHERST's National Qualifications Framework, all Certificate-level courses must be of 400-hours duration (equivalent to 10 weeks) – a key deterrent to PNG businesses sending their workers to training.
- NFC's campus location in Kavieng is not located near processing operations, although trainers can (and do) travel.

NFC is the proposed Centre of Excellence institution for the following reasons:

- NFC is already regionally focused – instructors have provided training in Kiribati, Tuvalu, Samoa, Solomon Islands under contracts from SPC and FFA. NFC students are from PNG, Nauru, Niue, Fiji, Kiribati, Tuvalu, FSM and South Korea.
- NFC's courses already meet the highest standards in the region. Courses delivered in other PICs could be adapted to better suit the competing demands of commercial operations, for example, by reducing course durations.
- NFC has a leadership team keen and committed to a regional approach.

By expanding NFC's remit, accessibility to training will be improved for the overall Pacific tuna sector while increasing the size of NFC's addressable market. NFC could also be used to deliver complementary courses such as financial literacy, which was successful in improving employee satisfaction and absenteeism levels when delivered under an IFC program for Soltuna, as employees were better able to manage household budgets and cashflow.

PROPOSED MODEL



Next steps

- Funding for a technical advisor to work with NFC Leadership developing a business case for the regional approach, to seek approval from the National Fisheries Authority.
- Once approved, NFC to actively market regional capabilities and collaborate with other institutions across the region.
- Recommend moving the NFC commercial fishing operations and post-harvest operations to the Pacific Industrial Maritime Zone (PMIZ) in Madang Province, while retaining the Kavieng campus for other activities, such as applied research.
- Longer term, consider a regional training standard.

FIGURE 24

NFC training delivered in 2022

	TOTAL	ON SITE		OFF SITE	
	# of courses	# of courses	Median # of students	# of courses	Median # of students
Commercial Fishing Operations	7	3	20	4	15
Post Harvest Operations	6	3	20	3	11
Aquaculture	3	2	18.5	0	-
Fisheries Business	2	1	21	2	26
Compliance and Governance	2	2	12	0	-

Analysis of National Fisheries College (2023) data

OPPORTUNITY 5

Collective approach for small businesses

Small businesses in the Pacific region are often isolated, resulting in high cost structures and limited access to resources and knowledge.

The lack of local competition can be detrimental to the business operating environment given the scarcity of case studies, examples and proof points. This can influence the success of small business requests for support and assistance from local government, banks and other service providers.

There are multiple examples of successful collaboration/collectivisation initiatives between small businesses in the Pacific but limited, if any, in the tuna sector. A collective approach to innovation in Pacific agriculture and fisheries would also be of benefit, building on existing work in this space.

NOW



Many businesses isolated across the Pacific region, making it difficult to achieve scale, and access resources and knowledge.

NEXT



Pacific tuna sector: Vessel food provisioning and online second-hand equipment market.

Collective approach: An online platform selling/promoting Pacific food innovation while bringing together businesses united by a shared food innovation mindset.

FUTURE



A Pacific food innovation hub, comprised of a central hub supporting small businesses through 'spokes', designed to achieve the critical success factors of integration, diversification and scale.

PACIFIC TUNA SECTOR

Vessel food provisioning

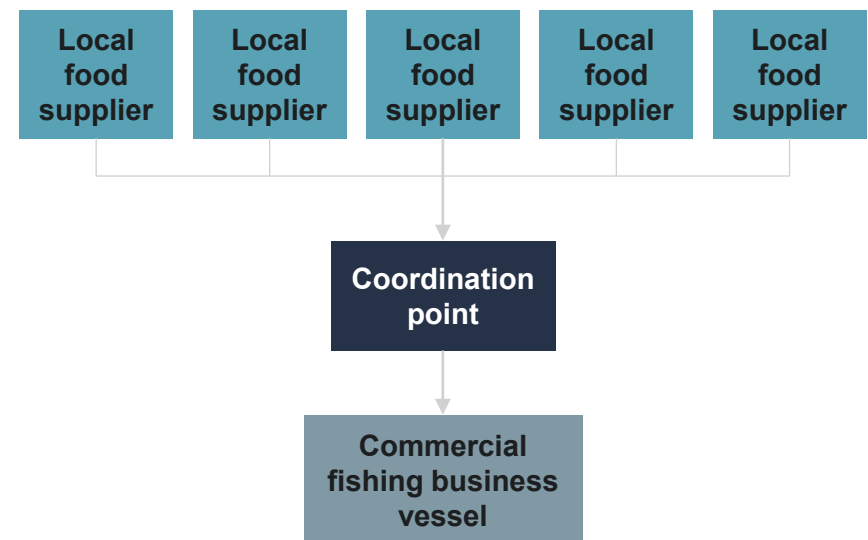
- One of the key provisioning requirements for vessels is food, which is typically comprised of imported food.
- There is an opportunity to improve the quality of food provided to crew members while supporting local food suppliers and displacing imports.
- Vessel food provisioning is already being carried out in Tonga by Pacific Sunrise Fishing, with an employee dedicating one-third of their time to this service stream. Food is sourced from the commercial fishing operation and produce from the employees' own household farming activities.
- In PNG, vessel food provisioning for tuna purse seine fleets is the responsibility of port agents, which could act as a coordination point.

Proposed approach

- Solomon Islands is well positioned for a similar enterprise to be established, with multiple local food suppliers situated near the port.
- NFD has shown interest in sourcing food locally and could be partnered with to develop the business model.
- Solomon Islands is also hosting the 2023 Pacific Games ('Sol2023') in November. Host country responsibilities include catering for athletes, officials, the workforce and spectators during the Games.
- Learnings, processes, suppliers and other resources developed for Sol2023 could be leveraged to develop the vessel food provisioning service.

Next steps

- Work with NFD to understand vessel food provisioning needs.
- Coordination role could be taken on by one of the small business suppliers or, depending on the level of demand, a new business opportunity created.
- Draw from Sol2023 experience post event to further develop the vessel food provisioning business model.



PACIFIC TUNA SECTOR

Online second-hand equipment market

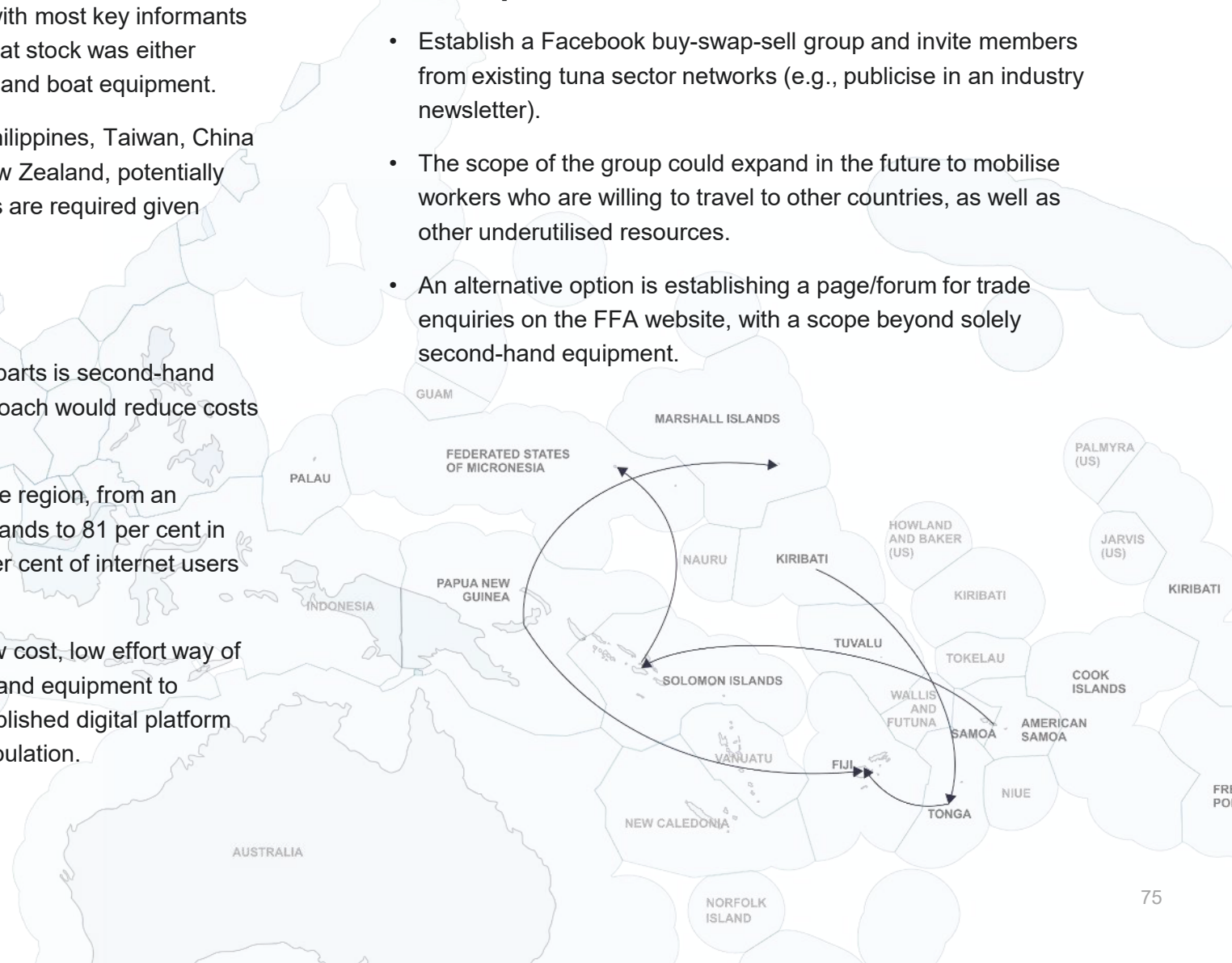
- Sourcing equipment and parts is challenging for tuna sector businesses, particularly for harvesters, with most key informants interviewed for this project mentioning that stock was either limited or not available locally for fishing and boat equipment.
- Equipment is generally imported from Philippines, Taiwan, China (i.e., place of vessel manufacture) or New Zealand, potentially resulting in downtime where critical parts are required given lengthy shipping times.

Proposed approach

- An alternative source of equipment and parts is second-hand equipment sourced regionally. This approach would reduce costs to businesses, wait times and waste.
- Although internet usage varies across the region, from an estimated 14 per cent in the Solomon Islands to 81 per cent in Niue, Facebook usage is close to 100 per cent of internet users across all countries¹.
- A Facebook buy-swap-sell group is a low cost, low effort way of enabling buyers and sellers of second-hand equipment to connect across the region using an established digital platform that is commonly used by the Pacific population.

Next steps

- Establish a Facebook buy-swap-sell group and invite members from existing tuna sector networks (e.g., publicise in an industry newsletter).
- The scope of the group could expand in the future to mobilise workers who are willing to travel to other countries, as well as other underutilised resources.
- An alternative option is establishing a page/forum for trade enquiries on the FFA website, with a scope beyond solely second-hand equipment.



¹ Khosla & Pillay (2020)

PACIFIC FOOD SECTOR

Pacific food innovation hub

The Pacific region is home to an incredible diversity of cultures, languages and people groups. Yet food has the power to bring people together. There has been growing interest in Pacific food innovation, focused on sustainability, health and cultural preservation.

While various projects and initiatives across the region support individual businesses, such as through SPC, Pacific Agribusiness Research in Development Initiative (PARDI) and the Pacific Horticultural and Agricultural Market Access Plus (PHAMA Plus) Program, there is an opportunity for an innovation hub that brings together like-minded businesses, including innovative small businesses in the Pacific tuna sector.

Proposed approach

- A collective model comprised of a member-owned hub supporting its small businesses members (hereinafter referred to as ‘the Collective’). Refer to the next page for a conceptual diagram of the potential future hub design.
- The Collective would focus on products from land and ocean resources, bringing together ‘Pacific pride’ with food innovation. Strengths of the model are the community-based approach that strongly aligns with Pacific values, while also contributing to improvements in the food and nutrition security of the region.

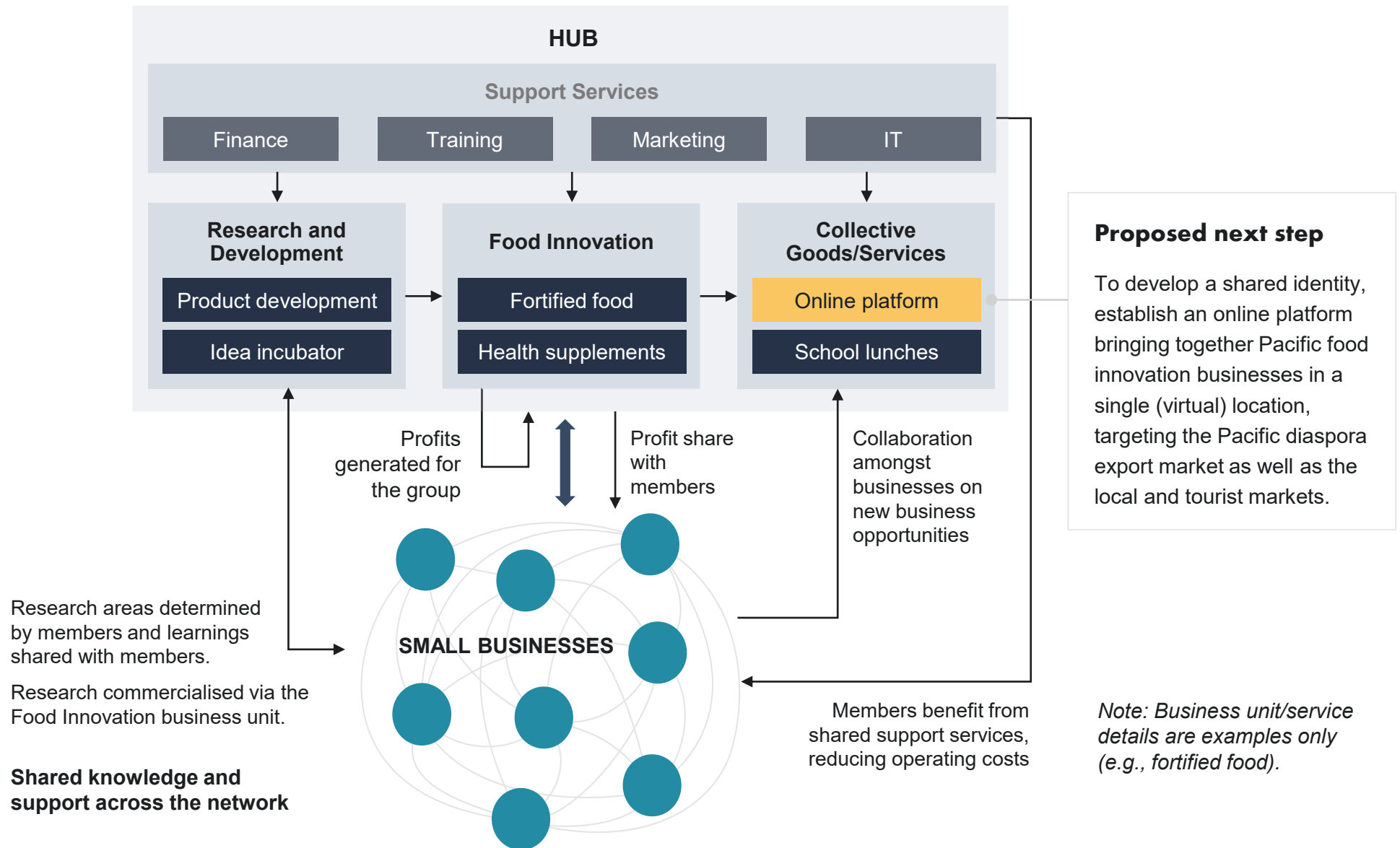
- Leverage existing innovation/entrepreneurial networks such as [Pacific Connect](#) and draw on learnings from projects such as PARDI, PHAMA Plus and other experience from the region.

Common features of successful hub-and-spoke models in the Pacific¹

- Driven business owner, investing a significant amount of time and energy into product and market identification
- Core business model run and managed by the owner/founder/CEO with a core team involved in management decisions and an extended network of suppliers.
- Partnerships with researchers and civil society organisations (CSOs) can be successful where there is agreement of roles and responsibilities and mutual trust and objectives. They are often able to support consultations with producers, training and ongoing mentoring for teams and supplier network – critical for quality control and scaling but where time poor small businesses struggle to invest in.
- Business advisory services, marketing and mentoring advice have been used to varying degrees to connect promising enterprises to market opportunities.
- Internal quality control mechanisms are utilised by all. Some of this has been supported by external partners.

¹ Talanoa Consulting (2022)

CONCEPTUAL MODEL



NEXT

Pacific innovation platform

An online platform where innovative Pacific food products are showcased and sold, sharing the stories behind the products, businesses and people.

Potential partners/resources:

- **Pacific Island Food Revolution** (PIFR) – A natural extension of the television series, the online platform would benefit from PIFR’s established brand, reputation, reach and in-house capacity. The concept has been discussed with and endorsed by Robert Oliver, Global Executive Director.
- **Pacific Trade Invest** (PTI) – Strong alignment with PTI’s remit. Recommend discussing the concept with Leata Alaimoana-Roberts, Queensland Trade Commissioner for the Pacific Islands and former Impact Investment Manager of PTI, particularly considering the significant Pacific diaspora in Queensland.
- **New Zealand Food Innovation Network** – An established food innovation hub in New Zealand that may be able to provide useful insights and/or support for a Pacific food innovation hub.

Learnings from previous/other similar initiatives¹:

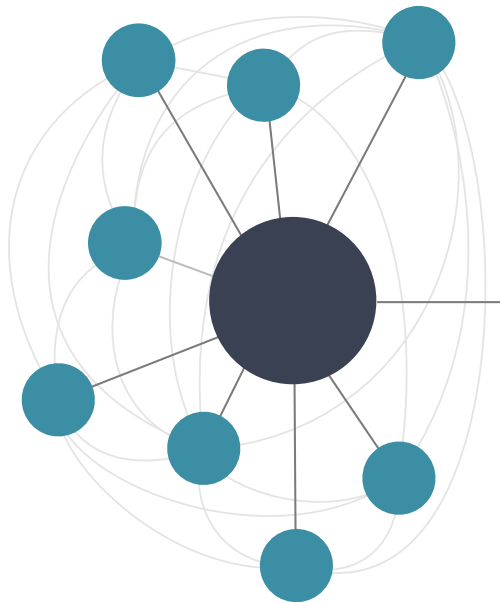
- Need to find the right food innovation businesses to partner with in every country to showcase the breadth and diversity of food products and to ensure equitable representation and buy in.
- Regional engagement needs to occur early in the process of developing the business model.
- Development of a medium-to-long term business plan is important to ensure focus and improve the likelihood of securing funding.
- The business model must be aligned with Pacific government priorities.

¹ Based on discussions between the project team and Robert Oliver, Pacific Island Food Revolution.



FUTURE

Preliminary discussions with Pacific businesses indicate that there is stronger interest in shared services relating to ad-hoc services such as training and business advisory, rather than core services such as finance.



Potential shared services

- Branding and marketing
- Contractual arrangements with larger companies (e.g., hotel chains)
- Product development
- Training and career pathways
- Facilitating shared knowledge across the Collective
- Access to finance
- Vessel repair services
- Bulk purchase of items such as gear
- Technical support

- **Branding and marketing** – A strong Pacific brand that provides small-scale businesses with a sense of belonging and a cohesive voice, targeting and representing the Pacific region. Provenance, sustainability and social responsibility are potential brand differentiators.
- **Stories** from across the Collective will help to build a strong narrative for the brand.
- **Diversified products and services** at scale. Scale will also reduce shared costs and enable access to markets.
- **Product development** facilitated and/or undertaken by the hub on behalf of the Collective, de-risking innovation.
- **Knowledge pathways** across the Collective to share knowledge across spokes, as well as link in with regional bodies to provide efficient dissemination of training.
- **Improved career pathways** through an intentional approach to talent development and broader range of pathways across the Collective.
- **Governance** to maintain Collective standards required to be competitive (e.g., consider traceability, certification over the longer time) and equitable outcomes for all involved, particularly vulnerable groups such as women and youth.
- **Access to finance** – The Collective’s commercial but for-purpose approach may enable access to alternative finance options, such as patient capital.

Given the importance of trust and relationships in the Pacific community, ensuring the right people are involved will be critical.

Looking to the horizon

Significant effort and investment has been channelled into the Pacific region over the past few decades to support the region's development. This section looks to the horizon and highlights a few key areas to watch that may provide significant benefits to the Pacific tuna sector over the longer term.



POSSIBILITY 1

Community owned infrastructure

There are many problems with infrastructure that is needed by many stakeholders in each local community. Examples are more and better wharves for fishing vessel offloading, and cold chain storage at wharves and airports to minimise disruptions due to transport delays.

Currently infrastructure development is funded either wholly by government or by well-funded private companies that then charge competitors to use it. Both these models have problems, but government investment is especially slow and prone to political intervention.

Using a public private partnership (PPP) model is one possible approach that could help attract investment into this sort of infrastructure, while ensuring that it delivers on the needs of the commercial fishing industry.

In many parts of the Pacific Islands, co-operatives have been used to help groups of private organisations or individuals to come together around a shared purpose in order to provide benefits to all members. This could be used to help local stakeholders co-fund development alongside government.

WHERE TO PLAY

Best suited to locations where there are multiple tuna industry stakeholders needing the same sort of communal infrastructure.

HOW TO WIN

Co-operatives work best when membership is voluntary, there is full economic participation and all will benefit, and management is independent of the cooperative members.

The PPP model can work well when there is true economic benefit from the investment and private organisations are committed to seeing community results.

WHAT WOULD HAVE TO BE TRUE?

The infrastructure (e.g., new wharf, cold storage) would have to be something all members want and need.

Sufficient government funding to deliver the project.

Other community interests are not harmed by the infrastructure development.

POSSIBILITY 2

Output financing innovations

Businesses raise finance through equity (investor) or debt (lender). Debt finance requires collateral to secure the loan, allowing the lender to use the collateral to recoup their losses in the event of loan default. This is often difficult for small businesses in the tuna sector, especially when banks prioritise land-based security as collateral (i.e., not vessels).

An Australian business, [Invest In Farming](#) (IIF) has recently taken a different approach. IIF operates as a co-operative whose members profit from farming without owning a farm. They buy a unit of production, for example a row of grapevines, a single cow or a basket of oysters.

The producer's profits from selling that unit of production are shared with the investor and IIF. This provides the producer with capital when they need it – at the start of the production cycle. This could be re-imagined to help finance vessel purchases or investment in waste processing.

Developments in finance innovation across other sectors/parts of the world should also be monitored in case there is scope to adapt new approaches for the Pacific tuna sector (e.g., warehouse receipts systems).

WHERE TO PLAY

Any part of the industry that has a key product to deliver and is constrained by access to operating capital.

IIF targets retail investors, but this model could target organisations looking to finance specific types of product, for example MSC-certified catch.

HOW TO WIN

Co-operative financing models shares the risk between the investors and the producer, whilst ensuring the producer is given early access to the value of their predicted output (similar to the Bulumakau Bank financing concept in Fiji¹).

It is important to select outputs that are the right size for target investors, distribute risk fairly, and still benefit the producer.

WHAT WOULD HAVE TO BE TRUE?

A co-operative platform would have to be established, or someone like IIF be open to expanding to the Pacific Islands.

Research undertaken to identify the segment(s) of the tuna value chain that would benefit most, potential investors and the ideal output.

¹ Fiji Times (2023)



05

CONCLUSION

Conclusion

The Pacific region benefits from the world's largest stocks of tuna. Tuna's versatility has led to extensive research across food, feed, industrial and biomedical end uses and over the longer term, unlocking some of these product innovations will be key to improving value retention from tuna resources for the region.

This highlights the increasing importance of the processing sector, particularly ensuring that the right skill set, and capabilities are available locally as greater sophistication in manufacturing practices will be required to access these product innovations. Product innovation will also mean an increased need for services to the sector, such as cold chain infrastructure and logistics and test labs.

The critical success factors of integration, diversification and scale are expected to become even more important as the global tuna sector becomes increasingly competitive. Given the Pacific operating environment, these factors may be difficult to achieve for any one business and therefore business model innovation to proxy these factors will be key.

Nonetheless there are significant constraints to both product and business model innovation in the Pacific region and therefore the role of government, regional bodies and multi-lateral/bi-lateral donors in improving the enabling environment will play a critical role in whether these opportunities can be translated into commercial outcomes. Furthermore, continued efforts to improve the underlying structural challenges of the Pacific tuna sector, particularly with respect to labour across the whole value chain, will be essential to ensuring maximum localisation of benefits.

FURTHER RESEARCH OPPORTUNITIES

Health and wellness inputs

Research specific to tuna harvested from the Pacific to determine the following:

- Bioactivity of peptides present in the hydrolysed tuna waste, to identify compounds present and their activities.
- Quantify specific bioactive yields and establish the processing parameters most effective for yields of different compounds.
- Understand the effect on nutritional component profiles of different batches of waste material used throughout harvest season.

This information will improve the value and competitiveness of products derived from Pacific tuna.

Fish meal, aqua and animal feeds

Research is required to identify feed formulations suitable for the needs of the target market (domestic or export) including nutritional requirements, digestibility, pellet size and buoyancy, using local ingredients where possible. The preferred processing method (milled, cooked, etc.) will also need to be determined.

Build on research findings from ACIAR project [FIS-2014-062](#) *Improving technologies for inland aquaculture in PNG*.



06

APPENDIX

- 1** References
- 2** Project alignment
- 3** Data notes
- 4** Product type by import country
- 5** Long list of opportunities
- 6** Water reclaiming from processing
- 7** Detailed production processes

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Appendix 2: Project alignment

The project is aligned with the following key strategies and priorities.

REGIONAL ROADMAP FOR SUSTAINABLE PACIFIC FISHERIES

The Pacific's key strategy for securing the sustainability of the region's fisheries sector.

- **Sustainability:** Sustainability of the four key tuna species, eliminating overfishing and reducing by-catch.
- **Value:** The region's tuna catch in 2024 will be worth double what it is in 2014.
- **Employment:** 18,000 new jobs will be created in the tuna industry within 10 years.
- **Food security:** The supply of tuna for domestic consumption in the region will increase by 40,000 tonnes per year by 2024, to provide nutritious food and reduce pressure on inshore resources.

ACIAR STRATEGIC OBJECTIVES

- **Food security and poverty reduction** – Aiming to increase retention of value for PICs, focusing on the distribution of value to small fishers, small to medium-sized fishing businesses and their communities.
- **Natural resources and climate change** – Sustainable resource management and maximum catch utilisation are key considerations for this project.
- **Inclusive value chains** – Aiming to increase participation from Pacific Island communities in the tuna industry.
- **Human health and nutrition** – A potential project outcome is identifying a concept(s) that will improve food and nutritional security.
- **Gender equity and women's empowerment** – Through development of inclusive value chains.
- **Capacity building** – Innovation Pathways identified through this project will likely require capacity building within PICs.

ACIAR PACIFIC PRIORITIES

- Improving food and nutritional security due to the high prevalence of nutrition-related diseases.
- Understanding and addressing the impacts of climate change on food systems resilience and livelihood security.
- Enabling inter-country collaboration through regional projects, capacity building, and supporting a stronger forum for exchange of ideas and experiences.

Appendix 3: Data notes

1. All currency figures are expressed in US dollars.
2. The focus of this project was on Papua New Guinea (PNG), Fiji and the Solomon Islands as key case study countries based on comparative tuna sector importance. In determining the level of importance of the sector, onshore processing volumes and the number of people employed by the sector were prioritised. Input has also been sought from other countries on a case-by-case basis, such as Samoa and Tonga.
3. Data sets were not always available for all in-scope countries. In these circumstances a note has been included with the relevant chart/data point.
4. FFA data sets
 - a. Where data has been sourced from FFA, 'Pacific region' refers to FFA members only.
 - b. Catch values reflect "delivered" values, that is, the value of the product when it enters its destination country.
 - c. Volume processed refers only to longline/purse seine catch processed to some form domestically onshore or on-board vessels; excludes volumes transhipped or delivered directly to offshore canneries.
 - d. Handling includes sorting and containerisation.
5. The World Bank 'Doing Business' index was discontinued in 2021 given concerns about the accuracy of data and allegations of manipulation. The data set has been used in this report as there is currently no better alternative and the allegations do not relate to the data that has been used in this report.

COVID

6. Where appropriate, five-year data averages have been used to smooth out the effects of COVID.
7. Key informant interviews were carried out over the period July 2022 to March 2023, during which COVID was still impacting local economies to varying degrees.

Appendix 4: Product type by import country

Based on import data from export destinations

From [Figure 19](#)

Product type	Thailand	US	EU	Japan	Product type	Notes
Fresh		Tuna albacore, bigeye, skipjack and yellowfin fresh.	Fresh/chilled albacore, bigeye, yellowfin tunas (excluding for industrial processing/ preservation).	Fresh/chilled albacore or longfinned tunas, bigeye, skipjack or stripe bellied bonito and yellowfin tunas.	Fresh whole round, loins, steak (LL)	Japan, US
Frozen	Fish, frozen, excluding fish fillets and other fish meat of heading 03.04 for albacore, bigeye, skipjack and yellowfin tunas.	Tuna albacore, bigeye, skipjack and yellowfin whole frozen.	Frozen albacore, bigeye, skipjack and yellowfin tunas "Thunnus alalunga" (excluding for industrial processing or preservation).	Frozen albacore or longfinned tunas, bigeye, skipjack or stripe belled bonito and yellowfin tunas.	Frozen loins (PS)	EU Thailand from PNA members and Vanuatu; minor % from Fiji
Loins	Tuna loins prepared or preserved.	Tuna, not in airtight containers, not in oil, over 6.8 kg.	Fillets known as loins of fish of the genus, skipjack, yellowfin, tunas prepared or preserved, whole or in pieces.	Fillets and meats – Albacore, bigeye, skipjack and yellowfin tunas.	Fresh/frozen loins (LL)	EU and US
Prepared or preserved		Tuna in airtight containers and oil.	Prepared or preserved bonito "sarda spp, skipjack, tunas, yellowfin tuna", whole or in pieces (excluding minced, fillets known as loins).	Prepared or preserved tunas, skipjack and Atlantic bonito, whole or in pieces (excluding minced).	Prepared or preserved (typically canned, PS)	EU

Source: Pacific Island Forum Fisheries Agency (2022c)

Appendix 5: Long list of opportunities

The below list excludes opportunities that were short-listed as these are covered in more detail in this report.

Opportunity	Description
★★★★	
Smoked tuna	● Increases storage life; additional product opportunities (e.g., tuna ham, bully beef import substitution).
Tuna jerky	● Limited uptake with the local population to date. Potential for tourist/export markets given lower transport costs and longer shelf life.
Nutritious convenience foods	● Nutritious alternative to staple meal of canned tuna on rice (e.g., steaks, portions, ready-made meals).
School lunches ¹	● Improve nutrition in school lunch programs, particularly boarding schools, i.e., most secondary schools.
★★★	
Micro-canneries	● Raw pack processing; more natural oils retained as the fish is cooked in the can.
Bottled tuna	● Can be produced using common cooking appliances.
Fish silage	● Aquaculture feed from tuna waste (greater digestibility).
Water reclaiming from processing	● Extract nutrients to produce other value-added products and reclaiming wastewater.
Integrated seafood restaurant	● Customers able to buy fresh fish and have it cooked at the same place; improved consumer experience.
Tuna essence	● Condensation process to create soup stock.
Pharmaceutical inputs	● Capsules, hydrogels, etc., from tuna skin gelatin; therapeutic benefits.
Green methanol fuel	● Tuna biomass for production of green methanol.
★★	
Biodiesel from tuna waste	● Fish oil for biodiesel given high fat content.
Reuse of old fishing gear/nets	● Re-use of waste products, e.g., for pot scourers.
Pet food	● Tuna waste for pet food (high protein, nutrients and oils).
Leather	● Leather from tuna skins.
Biodegradable plastic	● Collagen from tuna skin can be incorporated with other material to create biodegradable plastics.
Waste oil from fishing vessels	● Re-use of waste products.
Aquaculture	● Farmed tuna.

¹ Linkage with ACIAR project *HORT/2021/159 Understanding School Food Provision in the Pacific: Scoping the potential of local food systems to improve diets, nutrition and livelihoods.*

Appendix 6: Water reclaiming from processing

Tuna processing consumes large volumes of water per tonne of product. Discharge volumes can be extremely high, up to 10 L per minute within large processing operations.

Although discharged wastewater is specific to the processing operation, there are certain characteristics which are fairly consistent.

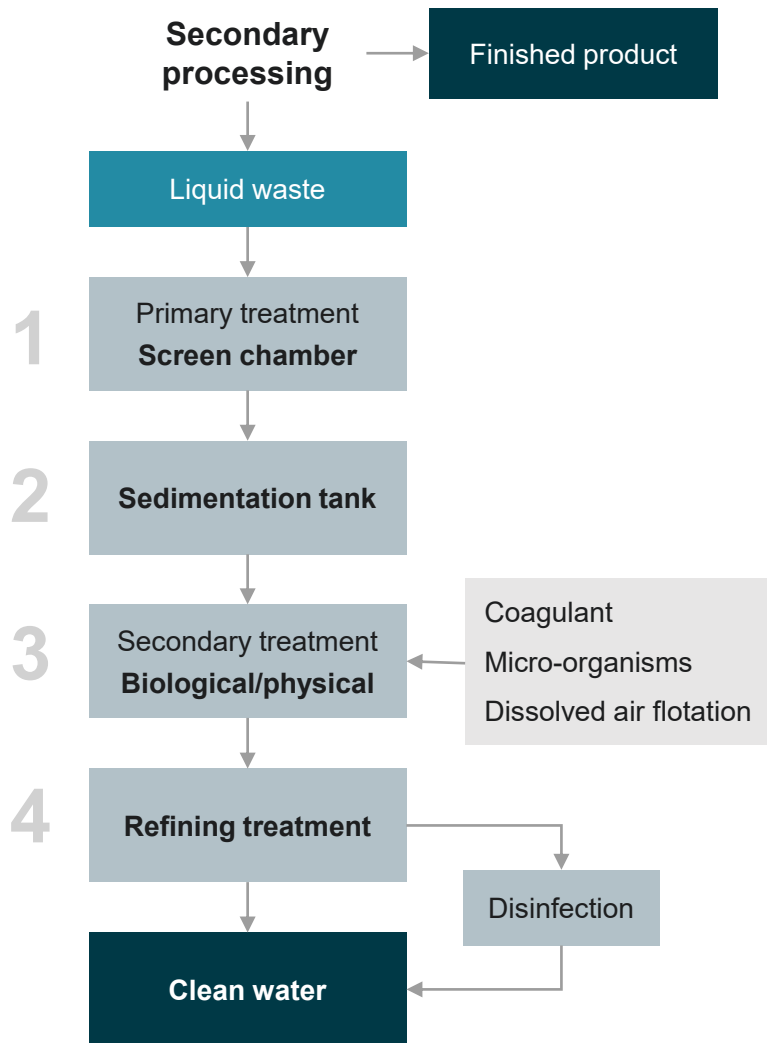
Wastewater composition

- Substantial levels of soluble, colloidal and particular material.
- Has high biological oxygen demand, fat, oil and grease, and chemical oxygen demand.
- Extent of contamination depends on specific operation.

Reclaiming wastewater

- Could provide opportunities for retaining suspended solid material.
- Potentially provides an additional supply of recycled water, particularly for smaller operations that do not have a consistent or affordable supply of water.

Strengths	Weaknesses
<ul style="list-style-type: none"> • Availability of wastewater. • Reduced dependence on an external water supply. • A degree of water self-sufficiency. • Low energy and input requirements. • Reliable water supply for processing as needed. 	<ul style="list-style-type: none"> • Additional equipment required. • Increased quality monitoring and documentation. • Technical support cost for treatment system. • Low treatment system operational experience available in the Pacific region.
Opportunities	Threats
<ul style="list-style-type: none"> • Reduction in water costs. • Increased processing capability. • Reclamation of solid waste material for value addition. • Environmental and sustainability gains. • Improved social license. • Capacity building within the region – less reliance on external expertise. 	<ul style="list-style-type: none"> • Power supply irregularities. • Water quality failure. • Influence of climate change on rainfall.

WASTEWATER TREATMENT**1 Primary treatment**

- Physical mesh screen in wastewater flow. Can use multiple screens with decreasing mesh-size to improve filtration.
- Removes coarse/medium sized solid material, including flesh proteins, skin, bone scales.
- Reduces total suspended solids and biological oxygen demand parameter by removing bacteria/algae attached to solid material.
- Fine suspended solid material remains in water flow.

2 Sedimentation tank

- Fats/oils/grease can be skimmed from the surface.
- Fine suspended solids settle on tank bottom and are removed to sludge reservoir.
- Sedimentation process can be enhanced by the addition of chemical compounds (e.g., calcium carbonate), which react with dissolved and suspended solids to become heavier than water and settling out.

3 Secondary treatment

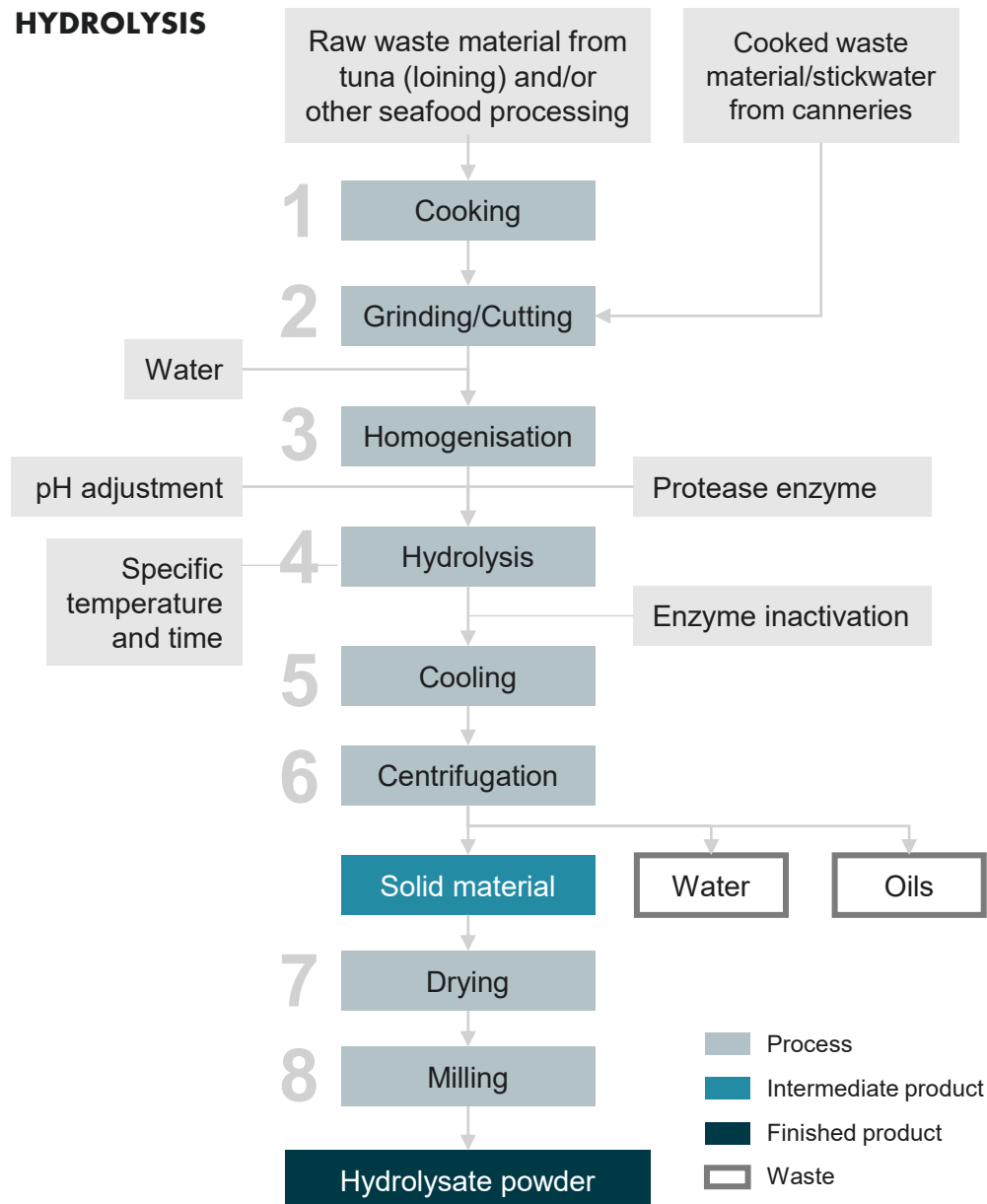
- Often a biological step, using mixtures of micro-organisms and aeration.
- Can also use a physical system: dissolved air flotation.
- Removes fine suspended and dissolved material. Reduces biological and chemical oxygen demand.

4 Refining treatment

- Removes any remaining fine suspended solid material, biological and chemical oxygen demand. Purifies water to drinking quality level.
- Typically uses membrane technology such as reverse osmosis.

Appendix 7: Detailed production processes

HYDROLYSIS



1 Cooking

Raw waste material must be cooked before processing.

2 Grinding/Cutting

Cooked fish, cooked waste and stickwater from canning (containing some solids) are combined and then cut or ground into small pieces.

3 Homogenisation

Water is added to help homogenise the resulting solids into a more consistently mixed result..

4 Hydrolysis

pH of the mixture is adjusted, and the specific protease enzyme required added. The process is then kept at a specific temperature run for a specific time.

5 Cooling

The enzyme digested mix is cooled down to room temperature.

6 Centrifugation

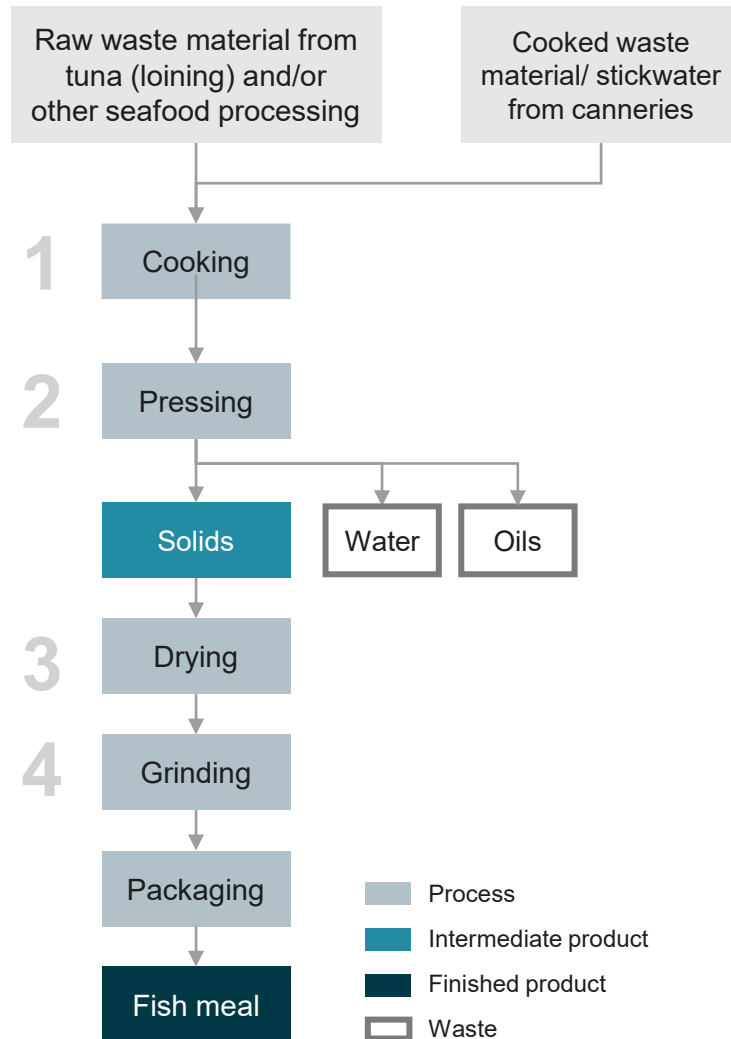
Used to separate the solids from wastewater and oils.

7 Drying

Hydrolysate solids dried so there is <10 per cent remaining water.

8 Milling

Dried hydrolysate solids milled to create hydrolysate powder.

FISH MEAL**1 Cooking**

Raw waste material must be cooked before processing.

2 Pressing

Cooked fish, cooked waste and stickwater from canning (containing some solids) are combined and pressed so that excess water, and oil are removed. The oil can be further processed at this point if omega-3 oils are desired as a product.

3 Drying

The resulting pressed solids are dried to remove the remaining unnecessary water.

4 Grinding

Grinding reduces the solids to a consistent size and texture. This makes it easier to package in bags or bins.