Green Climate Fund Regional Tuna Programme:

Feasibility Study

Chapter 1

Regional marine fisheries sector overview

Prepared by the Pacific Community and Conservation International on behalf of 14 Pacific Island countries for submission to the Green Climate Fund

November 2024

Annex 2-B of the Funding Proposal "Adapting tuna-dependent Pacific Island communities and economies to climate change"

Chapter 1: Regional marine fisheries sector overview

The Pacific Islands region is facing a climate emergency that "threatens the livelihoods, security and wellbeing of its people and ecosystems," as evidenced by "the latest science and the daily lived realities in Pacific communities."

Statement by Leaders at the conclusion of the 51st Pacific Islands Forum (PIF) Leaders Meeting, Suva, Fiji, 11–14 July 2022.

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1.1 Introduction

The ocean has, and always will, dominate the lives and livelihoods of the coastal communities of the Pacific Islands region, often referred to as Oceania. However, across an impressive history spanning 50,000 years (Box 1), the people of Oceania have never encountered the types of challenges they now face because of human-induced climate change.

This chapter sets the scene for understanding the fisheries resources of the Pacific Island region, and the threats posed by climate change to the communities and economies that depend on them. These resources are the coastal fish species in the immediate vicinity of the islands and the region's shared oceanic tuna resources (defined here as tuna and other pelagic 'tuna-like' fish species). Collectively, these fish species are arguably the most important natural living resources for Pacific Island people.

The chapter begins with a brief summary in Section 1.2 of the key features of the region where the 14 Pacific Island countries (PICs) participating in the GCF Regional Tuna Programme (RTP) are located. This summary covers the ethno-graphic structure, demography, governance and political stability, and vulnerability of the region. It also explains how the geography of PICs supports the coastal habitats, such as coral reefs, mangroves and seagrass meadows, that have historically provided much of the food needed for good nutrition of coastal communities across the Pacific Islands region. The summary information in Section 1.2 is supplemented by 'Profiles' for each of the 14 countries (**Appendix 1-A**). These documents provide further details about the politics and governance, geography, maritime areas, biogeography, demography (including ethnic composition), agriculture and fisheries sectors, and economic situation of each participating country.

Section 1.3 describes the nature of marine fisheries in the Pacific Island region. It commences with a summary of the diversity of coastal fish and invertebrate species used for food in the 14 participating countries, and the different fisheries that harvest them. It also identifies the subset of coastal fish and invertebrate species that support local livelihoods. The section concludes with a description of the major industrial fisheries that underpin the economies of the nine tuna-dependent Pacific Island countries participating in the RTP.

Section 1.4 provides an overview of the average production of coastal fisheries supporting communities across the region, and the catches made by industrial tuna fisheries in the exclusive economic zone (EEZs) of the 14 participating countries. This information illustrates the significance of the fisheries resources under threat from climate change.

Section 1.5 addresses the frequently asked question, "Are Pacific Island fish stocks overfished?". It explains that although some coastal fisheries in the vicinity of population centres have been over-exploited, coastal fish stocks in the many remote areas of PICs remain in a relatively healthy condition compared to other areas of the world. It also demonstrates, to the great credit of Pacific Island countries, that none of the tropical tuna species caught by industrial tuna fleets in the region have been overfished in the past, and overfishing is not presently occurring.

Section 1.6 describes the socio-economic benefits of fisheries resources in the Pacific Island region. It explains the importance of coastal fisheries production to nutrition of communities and the plans developed to maintain these benefits as human populations in the region continue to grow, and as climate change impacts the productivity of coastal fisheries. It also summarises the advantages that industrial tuna fisheries provide for countries participating in the RTP through employment and trade, government revenue derived from tuna-fishing access fees, and contributions to gross domestic product.

The chapter concludes with Section 1.7, which summarises the regional and national arrangements developed to support sustainable management of both coastal fisheries and industrial tuna fisheries.

Box 1. A snapshot of human habitation in the Pacific Island region

Based on archaeological records, humans from Southeast Asia began migrations into the Pacific east of Wallace's Line at least 50,000 years before present.[1] Migrating eastwards between islands in relative proximity to each other, humans had settled in New Guinea, the Bismarck Islands and the northern Solomon Islands by 50,000 years ago.[2] Beyond the main Solomon Island chain, to the east, islands are more widely dispersed. Requiring significant seafaring skills to navigate beyond sight of land, Vanuatu was settled from the west at least 3,000 years ago with ocean voyagers eventually reaching the outer islands of Polynesia.[3] This easterly migration is confirmed through studies on genome-wide variation, as well as on mitochondrial DNA and Y-chromosomes, which demonstrate that the ancestors of the people of eastern Polynesia are related to Papuan and East Asian populations.[4]

1.2 The region

The 22 Pacific Island countries and territories in Oceania in the Western and Central Pacific Ocean (WCPO) include some of the world's smallest countries. However, the shared 27 million km^2 of ocean under their combined jurisdictions is 98% larger than their combined land surface area (Figure 0.1).[5] Accordingly, they are often referred to 'large ocean States'.

Contemporary Oceania is generally grouped along ethno-geographic and cultural lines as "Melanesia, Micronesia, and Polynesia". The 14 countries participating in the RTP are spread across these three regions.

Melanesia is located in the south-west of the Pacific basin, north of Australia, and bordering eastern Indonesia. The region includes the four independent countries of Fiji, Papua New Guinea (PNG), Solomon Islands and Vanuatu (and the French territory of New Caledonia). Melanesia is dominated by relatively large, high islands and comprises 98% of the total land area of the Pacific Islands. The four Melanesian countries support ~85% of the total population of the 14 Pacific Island countries participating in the RTP (Table 1.1). Papua New Guinea is the largest country in Oceania (Error! Reference source not found.).

Micronesia consists of ~2,500 islands and the EEZs of the countries located there eligible for GCF support (Federated States of Micronesia, Kiribati, Marshall Islands, Nauru and Palau) (Figure 1.1) cover almost 9 million km^2 of the WCPO (Error! Reference source not found.). However, these Micronesian countries comprise only 0.4% of the total land area of the 14 participating countries and have about 2.5% of their combined total population (Error! Reference source not found.).

Polynesia comprises ~1,000 islands enclosed within a triangle bounded by Hawaii to the north, New Zealand to the southwest, and Easter Island to the east. The EEZs of the countries within Polynesia eligible for GCF support (Cook Islands, Niue, Samoa, Tonga and Tuvalu) (Figure 1.1) span close to 4 million km^2 (Error! Reference source not found.). These Polynesian countries comprise only about 0.8% of the total Pacific land area, and support <3% of the combined population of the 14 participating countries.

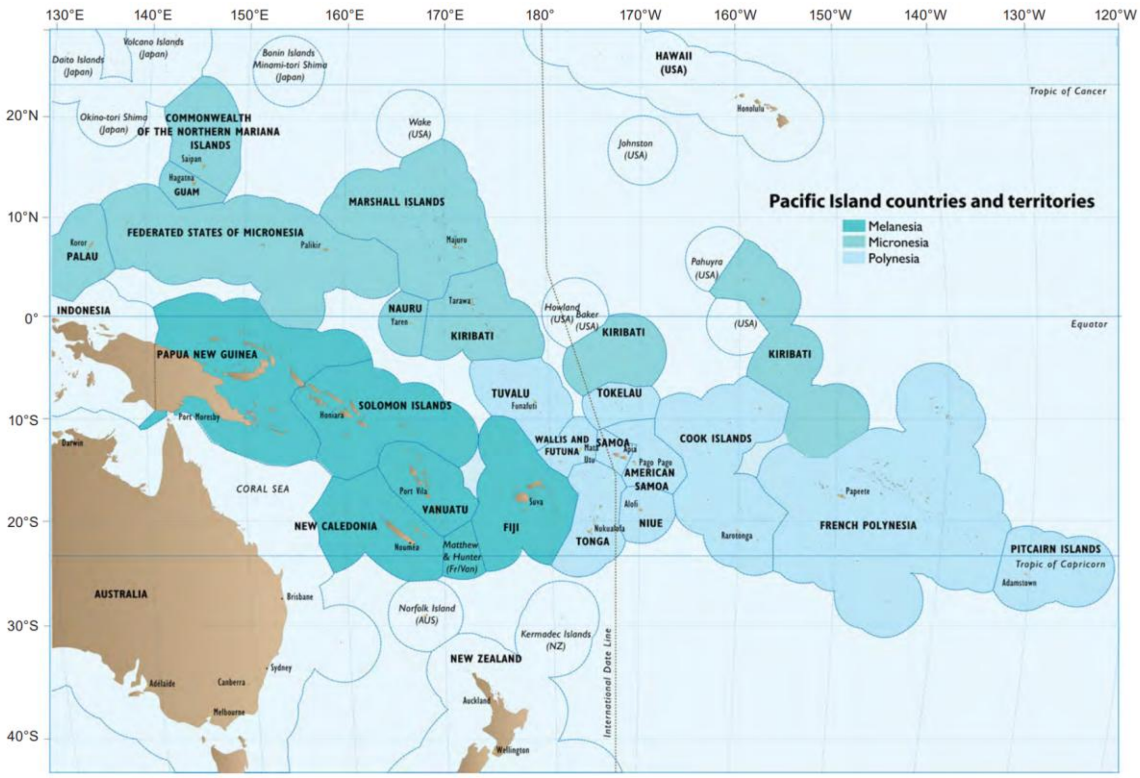

Figure 0.1.The Oceania region of the Western and Central Pacific Ocean with the ethno-geographic and cultural sub-regions of Melanesia, Micronesia and Polynesia.[6]

Table 0.1 Key geographical and population information for the 14 participating countries.[7]

Country and region	Population (mid-2022 est)	Land area (km^2)	EEZ area (km^2)	Coastline length (km)	Percentage of population living within 1km of coast	Percentage of population living within 5km of coast
Total	**11,894,867**	**528,047**	**17,628,364**	**24,326**		
Melanesia	**11,265,825**	**521,684**	**4,956,561**	**14,122**		
Fiji Islands	901,603	18,333	1,255,290	1,129	27.2	76.4
Papua New Guinea	9,311,874	462,840	1,558,660	5,152	8.0	21.1
Solomon Islands	744,407	28,230	1,547,600	5,313	65.1	91.4
Vanuatu	307,941	12,281	595,011	2,528	64.1	94.3
Micronesia	**301,044**	**2,158**	**8,906,382**	**9,174**		
Federated States of Micronesia	105,987	701	2,907,950	6,112	88.5	100
Kiribati	122,735	811	3,333,170	1,143	100	
Marshall Islands	42,418	181	1,774,280	370	100	
Nauru	11,928	21	309,044	30	92.6	100
Palau	17,976	444	581,938	1,519	93.5	100
Polynesia	**327,998**	**4,205**	**3,765,421**	**1,030**		
Cook Islands	15,406	237	1,969,960	120	90.7	100
Niue	1,532	259	317,787	64	24.7	83.0
Samoa	200,999	2,934	123,278	403	61.1	97.2
Tonga	99,283	749	628,614	419	84.3	100
Tuvalu	10,778	26	725,782	24	100	

Approximately 7.9 million people live within 5 km of the coast in Melanesia and, of these, 4.6 million live within 1 km of the coast (Figure 0.2). Almost the entire population of Micronesia lives within 5 km of the coast, with less than 6,000 residents living more than 5 km of the coast. In Polynesia, 311,800 people live within 5 km of the coast, with almost 214,000 of these people living within 1 km of the coast.

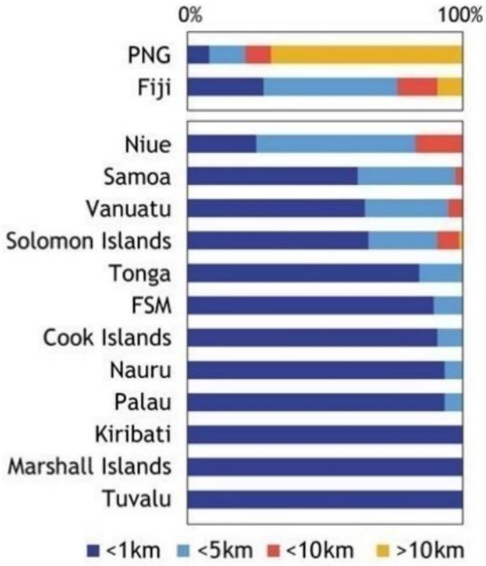

Figure 0.2 Proportion of participating country populations within defined distances from the coast.[8]

1.2.1 Governance and political stability

The 14 countries participating in the RTP are all independent, although five have association status: Palau, FSM and Marshall Islands maintain a compact of free association with the United States, and Cook Islands and Niue share associated status with New Zealand.[9]

The participating countries in Micronesia and Polynesia are characterised by small populations, high dependence on development assistance and relative political stability since achieving independence. Occasional domestic tensions have been experienced in Tonga, where rioting in 2006 resulted in the adoption of a democratic constitution in 2010 that has resulted in political stability. Although Nauru has experienced numerous political crises and consequent changes of government in the past it has been politically stable in recent years.[10]

In Melanesia, Papua New Guinea, Solomon Islands, and Vanuatu feature broad linguistic and cultural diversity. This has arisen due to their relatively large land masses, and wide disbursement of populations due to an extremely rugged geography, which has historically limited communication between communities. Although mobile phone services have improved communication significantly, the more remote inland and outer island locations in Melanesia remain relatively isolated. These features combine to create substantial challenges to nationwide political harmony and integration.

This challenge manifested in the ethnic unrest on the Island of Guadalcanal in Solomon Islands during the late 1990s/early 2000s, and which has continued to surface periodically in the capital of Honiara since then. Earlier, between 1988 and 1998, the most violent conflict in the Pacific region since the Second World War erupted on the islands of Bougainville, now an autonomous region in Papua New Guinea.[11] The conflict was fuelled by a combination of factors including a desire for self-determination, land disputes and environmental damage related to a large copper mine that operated in Bougainville from 1971. These grievances resulted in violence, which escalated over eight years, resulting in many deaths and closure of the mine. A ceasefire and a series of peace negotiations took place in the mid-1990s, which led to the signing of the Bougainville Peace Agreement (BPA) in 2001. The BPA granted Bougainville autonomous status, establishing the Autonomous Bougainville Government (ABG). A referendum on Bougainville's political status in 2019 resulted in almost 98% of voters supporting independence. The mine remains closed and efforts to operationalise the BPA continue today.

In recent years, the leadership in Vanuatu has changed at irregular intervals because of parliamentary votes of no confidence.

Fiji supports an effective state administration but, unlike its Pacific neighbours, has a strong military which has intervened in the democratic process on several occasions since the mid-1990s. These interventions have resulted in the installation of new governments supported by the military.

In general, governance systems in the Pacific Island region have evolved in cultures that historically placed high values on kin connections and kin loyalty and a distribution of power, wealth, and opportunities. For many Pacific Island countries, the State as the modern form of political organisation came with colonial rule under either a Westminster or American presidential system of government. However, once the colonists departed, Pacific Islanders soon adapted these systems to their own expectations and assumptions, creating the contemporary forms of Island government in place today.[8]

Except for Fiji, regular democratic elections have determined who governs the 14 Pacific Island countries participating in the RTP, and their democratic record is impressive relative to other developing regions of the globe.

1.2.2 Vulnerability of Pacific Island countries

The Pacific region is vulnerable to shocks given the political and governance characteristics described above, and its geographical location and attributes (Section 1.2.2). 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.[1] Some of the risks listed above are related to the region's location along the Ring of Fire and exacerbated by the fact that many PICs have low-lying coastal zones, making them particularly vulnerable to natural disasters. Average economic losses to the region as a result of natural disasters are estimated to be US$1.075 billion per year, with ~50% attributable to tropical cyclones – equivalent to nearly 5 per cent of the combined Gross Domestic Product of all Pacific small island developing states.[12]

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 Federated States of Micronesia (FSM) both rank in the lowest scoring countries for EVI (Economic and Environmental Vulnerability Index) and Economic Vulnerability (EVI sub-index), respectively, signifying very high structural vulnerability to shocks.

The vulnerability of communities and economies in the participating countries to the effects of climate change on the region's valuable fisheries resources is explained in detail in **Chapter 2**.

[1] 'Food security' is used here in the context of the 'food availability' pillar of food security

1.2.2 Geography, coastal habitats and ocean features

1.2.2.1 Geography

As mentioned above, two broad types of islands predominate in the Pacific Island region: high islands and atolls/uplifted atolls. Very young high volcanic islands, raised from the ocean floor through volcanic activity and tectonic forces, have little reef development beyond encrusting coral communities, whereas older high islands may have well-developed, fringing coral reefs.[13] When high islands eventually subside beneath the surface of the ocean, the fringing coral reefs continue to grow, forming atolls with lagoons. In some cases, atolls can be uplifted by subsequent volcanic activity to become a solid landmass. The participating countries fall into four categories with respect to these two broad island types: 1) high islands only (Samoa, Vanuatu); 2) predominance of high islands with some atolls/uplifted atolls (Fiji, Palau, Papua New Guinea, Solomon Islands, Tonga), 3) predominance of atolls/uplifted atolls with some high islands (Federated States of Micronesia, Cook Islands); and 4) atolls/uplifted atolls only (Kiribati, Marshall Islands, Nauru, Niue, Tuvalu).

1.2.2.2 Coastal habitats

Nearly all the Pacific Island countries lie within the tropics (Figure 0.1). As a result, the dominant coastal fish habitats across the Pacific Islands region are coral reefs (Table 1.2). However, larger high islands can also have extensive fresh and brackish water habitats, including nutrient-rich rivers that can carry large quantities of silt, resulting in more-productive, but more turbid, coastal habitats. In western parts of the region, mangrove forests thrive along the intertidal shorelines, particularly in estuaries and near river mouths, and seagrasses flourish on silty inner reef flats and shallow lagoon floors (see details below).[14] Atolls are dominated by coral reef habitats because they generally lack conditions for growth of mangroves and are often too remote to have been colonised by seagrasses.

Coral reefs

All forms of coral reef development can be found in the Pacific Island region, including large barrier reefs in Fiji, extensive fringing reefs around the large Melanesian islands, and patch and submerged reefs, banks and shoals.[15] The corals of the Pacific Island region have been described[16] but not as fully as for Australia, where over 330 species of hermatypic or reef building corals from 70 genera have been recorded.[17] The number of coral species declines in an easterly direction across the Pacific Island region, in common with the distribution of fish and invertebrate species.[18] The importance of coral reefs as fish habitat is widely reported and has been summarised in a book produced by the Pacific Community.[19] The important role that coral reef fish play in domestic food security in Pacific Island countries has also been documented.[20]

Mangroves

Mangrove forests are prevalent in estuarine areas but sediment build-up may also permit establishment of some mangroves on reef flats. Extensive mangrove forests are a feature of high islands in the western Pacific, particularly in Melanesia (Table 1.2), and the greatest species diversity of mangroves in the world occurs in PNG.[21] The natural eastern limit of mangroves in the Pacific is Samoa. Information on the distribution and ecology of Pacific Island mangrove forests has been compiled and reviewed[22,23], and included in a global evaluation of tropical marine ecosystems.[24] From a fisheries perspective, mangroves are important as nursery grounds for penaeid shrimps and some inshore fish species. They also provide foraging areas for a wide range of coastal fish species at high time and habitat for crabs and some other commercially valuable crustaceans.[25]

Seagrasses

Seagrasses are common in many inshore areas in the Pacific Island region (Table 1.2). Seagrasses stabilize and increase sedimentation because their leaves and rhizomes form a complex matrix that slows current flow, binds sediments and stops erosion.[26] Summaries of the seagrass species found in the WCPO, their ecology and their contribution to the mosaic of coastal habitats in the Pacific Islands region is also well documented.[27] Seagrass beds provide fish nursery areas and habitat for some commercially-valuable penaeid shrimps and sea cucumbers. They also provide food for herbivorous coastal fish species, such as surgeon fish and rabbit fish, and for dugongs and green turtles.

The projected effects of climate change on the area and quality of the important coral reef, mangrove and seagrass coastal fish habitats are assessed in Chapter 2.

Table 0.2. Estimated area (km^2) of coastal habitats in each participating country (sources: WRI – World Resources Institute; WCMC – World Conservation Monitoring Centre [UNEP]; GMW – Global Mangrove Watch). FSM = Federated States of Micronesia; PNG = Papua New Guinea. Blank cells indicate that the habitat does not occur in the country.[28]

Country	Estimated habitat area in 2022 (km^2)		
	Coral reef (WRI data)	Seagrass meadow (WCMC data)	Mangrove forest (GMW data)
Melanesia			
Fiji	6,741.7	1,745.6	488.1
PNG	14,686.6	9,347.4	4,524.7
Solomon Islands	6,790.6	1,261.7	526.5
Vanuatu	1,813.0	1,244.7	15.8
Micronesia			
FSM	4,957.0	1,594.6	87.9
Kiribati	3,061.2	499.6	1.5
Marshall Islands	3,581.0	529.3	0.3
Nauru	15.4		
Palau	972.3	732.2	56.9
Polynesia			
Cook Islands	530.8		<0.1
Niue	44.7		
Samoa	404.2	988.7	2.3
Tonga	1,670.4	3,703.4	10.4
Tuvalu	1,238.2	-	0.1
Total	**46,506.9**	**21,647.1**	**5,714.7**

1.2.2.3 Features of the Pacific Ocean

The productive tuna fisheries of the WCPO are associated with five ecological provinces located between approximately 10°N and 10°S: the Pacific Equatorial Divergence (PEQD), Western Pacific Warm Pool (Warm Pool), North Pacific Tropical Gyre (NPTG), South Pacific Subtropical Gyre (SPSG) and Archipelagic Deep Basins Province (ARCH) (Error! Reference source not found.**,** see also additional detail in Chapter 2). The borders of these provinces are generally defined by convergence zones of surface currents, and each province has a specific wind regime and vertical hydrological structure.[29]

The EEZs of nine of the 14 Pacific Island participating countries are located in the region covered by PEQD and the Warm Pool, which dominate the equatorial waters between 10°N and 10°S (Figure 1.1, Figure 1.3). The oceanic conditions found within these two provinces largely support the world's largest tuna fishery.

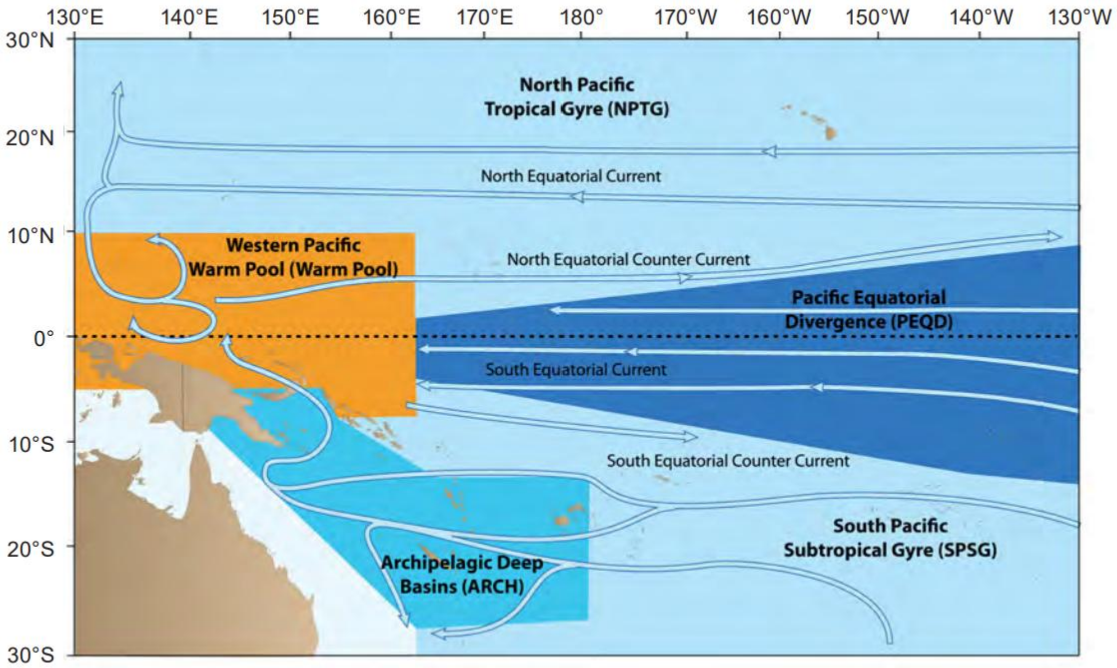

Figure 0.3. The five ecological provinces of the tropical Pacific Ocean, together with the major ocean currents of the region.[30]

The locations of the PEQD and the Warm Pool can change from year to year, depending on the prevailing El Niño-Southern Oscillation (ENSO) conditions, which alter the extent of upwelling in the eastern and central equatorial Pacific and the nitrate concentrations of the surface waters.[31] The ARCH province is characterised by the occurrence of many archipelagos and seamounts. It is a patchwork of processes, on a variety of spatial scales, with varied vertical structures, driven by the way the landmasses divert surface currents and create eddies. This province also receives nutrients due to runoff from the high islands located there.[32] On both sides of the equatorial band, the large atmospheric anticyclones in the northern and southern subtropical Pacific generate oceanic gyres. The ecological provinces in these areas (NPTG and SPSG) are characterised by a very deep but weak thermocline which allows some nutrient inputs to the photic zone from deep water through mixing and diffusion. However, during summer, a strong and shallower (40–60 m) thermocline is superimposed on the main thermocline, due to the increase in solar radiation, creating a significant barrier to nutrient inputs. This leads to lower primary production in the upper part of the photic zone in NPTG and SPSG in summer compared with the rest of the year.

Details of the vertical hydrological structure and associated physical processes of each province, which have a profound effect on the phytoplankton productivity available to supply the base of the food web for tuna, are summarised in **Appendix 1-B** and in **Chapter 2**.

1.3 Nature of marine fisheries

1.3.1 Diversity of coastal fisheries species

The Pacific Island region possesses extensive coral reef systems and, as part of the western Pacific, has some of the highest marine diversity in the world.[33,34]

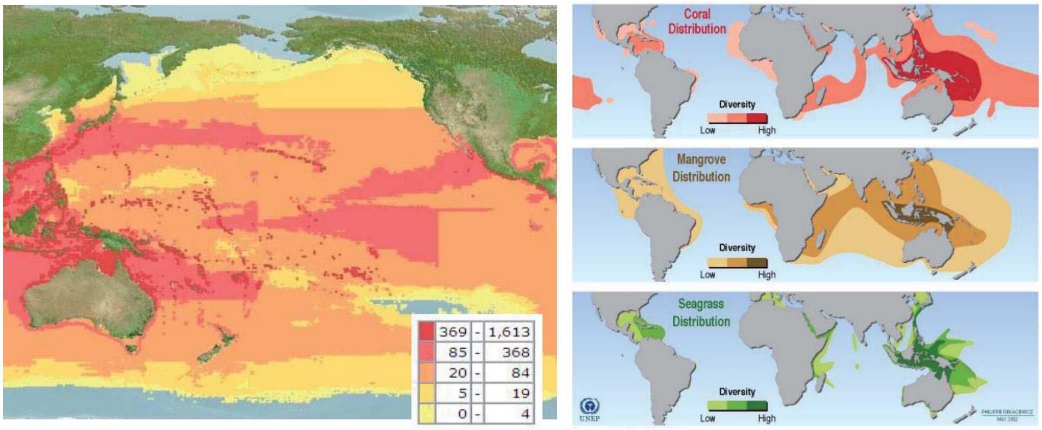

Figure 0.4. Marine biodiversity in the Pacific Ocean. Species richness map for animals in the Pacific Ocean, based on 7,242 species (left) (source: Fishbase/OBIS13); and global distribution of coral, mangrove and seagrass diversity (right) (source:UNEP/ WCMC 2001).[35]

The diversity of fishes, molluscs, echinoderms and crustaceans declines in an easterly direction across the Pacific. There are about 2,500 reef and inshore species of fish recorded from the Philippines, at the centre of the Indo-Pacific faunal continuum, compared with only 125 in Easter Island at the eastern margin of the region.[36] This species gradient is related to the position of the Pacific Island countries in relation to the Pacific Plate.[37,38]

The rich diversity of fish and invertebrate species associated with coastal habitats in the region is reflected in the diets of Pacific Island people. The main families of fish species closely associated with coral reefs targeted by small-scale subsistence and artisanal fishers in the participating countries is shown in Table 1.3. In addition, skipjack, yellowfin, bigeye and albacore tunas, and a range of other pelagic fish species occurring in nearshore waters, e.g., Spanish mackerel, large jacks, rainbow runner and mackerels, are also commonly caught by coastal communities in the region.[39]

Pacific coastal communities also use a wide diversity of molluscs, echinoderms and crustaceans for food.[40] In addition to the range of shell-bearing (gastropod and bivalve) molluscs, cephalopods such as squids, cuttlefish and octopus are harvested from coastal habitats. Trochus, green snail and black-lip pearl oyster are harvested for mother-of-pearl and exported for use in button manufacture and furniture inlay. The black-lip pearl oyster is also used to produce cultured pearls in some participating counties Cook Islands and Fiji).

The diverse fauna of holothurian echinoderms (sea cucumbers) in the region[41] contribute to the subsistence diet of many Pacific Islanders. In addition, more than 20 sea cucumber species are commercially valuable as a dried product (known as beche-de-mer, or trepang) and exported mainly to Asia.[42]

The variety of crustaceans consumed by Pacific Island people include crabs, land crabs, spiny lobsters, slipper lobsters, mud lobster, mantis shrimp, polychaete worms and a range of penaeid shrimps.[43,44,45,46]

Further details of the fish commonly used for food in the participating countries, and exported to support livelihoods, are provided in **Appendix 1-C**.

Table 0.3. Percentage composition of the main families of coral reef fish caught by coastal communities in the participating countries. Information based on extrapolated catches from socio-economic surveys by SPC at 4–5 sites in each country between 2002 and 2008. The trophic group of each fish family is designated as carnivore © or herbivore (H).[47]

Country	Family (percentage total catch)											
	Lethrinidae ©	Acanthuridae (H)	Scaridae (H)	Serranidae ©	Lutjanidae ©	Siganidae (H)	Holocentridae ©	Mullidae ©	Kyphosidae (H)	Labridae ©	Balistidae ©	Others* ©
Melanesia	**20.4**	**7.2**	**8.4**	**8.5**	**8.9**	**6.4**	**1.3**	**3.6**	**1.2**	**0.9**	**2.4**	**30.7**
Fiji	37.4	7.7	2.8	9.4	8.0	1.4	1.8	2.1	0.0	0.0	1.8	27.6
Papua New Guinea	14.5	1.9	5.8	5.2	16.0	4.2	0.7	2.1	1.8	0.7	2.1	44.9
Solomon Islands	10.5	5.5	9.2	13.1	18.1	2.0	3.3	1.8	0.1	3.9	4.0	28.5
Vanuatu	17.8	9.0	12.1	1.3	0.9	13.3	1.2	7.6	4.4	0.0	4.5	27.8
Micronesia	**12.8**	**14.0**	**11.4**	**14.3**	**10.9**	**9.1**	**2.1**	**3.1**	**1.7**	**0.7**	**0.3**	**19.7**
FSM	7.8	29.3	26.4	8.1	1.2	14.0	0.1	2.9	0.0	1.0	0.0	9.2
Kiribati	9.2	2.5	2.0	10.8	11.0	0.4	2.0	3.6	0.3	1.0	0.1	57.2
Marshall Islands	10.5	9.5	4.5	28.8	17.2	12.2	3.0	3.7	5.6	0.2	0.3	4.6
Nauru	0.0	34.1	8.3	6.6	10.4	0.0	10.9	0.0	4.5	0.0	4.0	21.2
Palau	26.8	9.5	13.5	11.4	14.4	12.1	0.9	3.1	0.4	0.6	0.1	7.1
Polynesia	**13.2**	**16.8**	**15.4**	**8.4**	**7.2**	**3.1**	**6.1**	**2.8**	**5.7**	**1.3**	**0.2**	**19.8**
Cook Islands	2.6	10.4	36.8	9.7	2.3	4.6	4.9	4.1	14.5	2.3	0.0	7.9
Niue	0.3	2.4	2.2	6.4	1.3	0.0	22.3	1.2	25.0	4.7	0.3	34.0
Samoa	13.6	22.9	18.7	5.0	5.4	5.1	8.1	3.7	0.7	1.9	0.8	14.0
Tonga	40.3	12.9	11.0	10.9	9.4	4.7	0.8	1.4	1.5	1.3	0.2	5.5
Tuvalu	9.4	17.4	3.1	10.9	14.7	0.8	4.1	0.8	8.7	0.1	0.0	29.9

1.3.2 Coastal fisheries

In the Pacific Island region, coastal fisheries are based on harvesting wild fish and invertebrates from inshore coastal habitats to a depth of 50 m, as well as the capture of tuna and other pelagic fish caught in neritic waters (the photic zone to a depth of 200 m extending ~10 km of the coast in the Pacific Island region).[48] These coastal waters are the focus of discussion relating to vulnerability of coastal fisheries in the technical documentation prepared for the RTP.[49]

The coastal fisheries of the region considered during the development of this GCF Funding Proposal target three categories of fisheries resources (1) demersal (bottom-dwelling) fish, (2) nearshore pelagic fish and (3) invertebrates.[50,51]

It should be noted that fishing activities targeting some species occurring within coastal waters are not included because they do not contribute significantly to the diet of coastal communities. These include deep slope fisheries for snappers and groupers because the catch is sold mainly to the restaurant trade, often for consumption by tourists. The capture of turtles, crocodiles, dolphins and dugongs is not included because although these animals are used for food during culturally important events, they generally make a limited contribution to subsistence in the countries where they occur. These species are also increasingly subject to environmental protection or regulations based on customary use.[52]

1.3.2.1 Demersal fisheries

These fisheries target the diverse range of fish species associated with coastal benthic habitats. As noted above, the greatest abundance and diversity of fish are caught around coral reefs.[53] However, fishing also occurs close to mangroves, in seagrass meadows and over soft-substrate habitats with little biological structure.

As shown in Table 1.3, although the main families of demersal fish caught for domestic consumption are fairly consistent across the participating countries some differences in consumption occur. In Melanesia, catches of demersal fish are comprised mainly of emperors, whereas the composition of catches varies within Micronesia and Polynesia. Across the latter two regions, carnivorous species dominate catches in Kiribati, Marshall Islands, Palau and Tonga, whereas herbivorous fish species, e.g., surgeonfish, parrotfish and rabbitfish, are caught more often in Cook Islands, Federated States of Micronesia (FSM), Nauru and Samoa (Error! Reference source not found.).[54]

Table 0.4. Average biomass (tonnes per km^2) of commonly-harvested demersal fish families associated with coral reef habitats in the participating countries, based on underwater visual census at 1–4 coral reef habitats at 4–5 sites within each country between 2002 and 2008. The trophic group of each family is designated as carnivore (C) or herbivore (H).[55]

Country	Family (average biomass in tonnes per km^2)										
	Acanthuridae (H)	**Scaridae (H)**	**Lutjanidae (C)**	**Lethrinidae (C)**	**Balistidae (C)**	**Mullidae (C)**	**Serranidae (C)**	**Labridae (C)**	**Holocentridae (C)**	**Siganidae (H)**	**Kyphosidae (H)**
Melanesia	**40.90**	**35.04**	**15.00**	**6.56**	**2.87**	**4.48**	**2.33**	**3.03**	**2.17**	**3.52**	**1.34**
Fiji	27.23	30.61	10.20	4.36	1.07	3.24	1.36	3.48	0.71	4.79	0.16
Papua New Guinea	54.49	29.27	20.23	6.49	2.82	4.07	1.92	2.46	3.57	1.85	1.92
Solomon Islands	44.67	22.35	21.84	13.07	7.46	7.85	3.23	2.76	4.02	4.32	0.18
Vanuatu	51.84	51.73	19.44	5.78	2.67	3.41	2.77	4.31	2.11	3.20	4.32
Micronesia	**62.25**	**16.62**	**25.67**	**8.92**	**12.52**	**2.11**	**4.08**	**3.36**	**2.00**	**0.88**	**1.33**
FSM	28.25	25.92	10.24	9.05	1.74	1.57	0.68	1.34	1.72	0.84	1.28
Kiribati	72.86	18.48	88.42	18.43	24.18	2.67	12.64	12.19	2.68	0.17	3.57
Marshall Islands	22.01	17.29	10.80	8.39	1.29	3.29	3.80	0.91	1.96	1.08	0.03
Nauru	153.36	6.91	4.29	4.51	34.18	0.15	2.05	0.08	1.45	0.07	
Palau	34.78	14.52	14.59	4.24	1.18	2.87	1.26	2.28	2.20	2.24	0.43
Polynesia	**40.40**	**17.78**	**7.34**	**4.77**	**3.91**	**3.57**	**2.65**	**1.50**	**1.13**	**0.79**	**1.56**
Cook Islands	59.29	13.82	1.20	2.95	1.72	12.34	3.87	1.80	0.59	0.29	0.67
Niue	34.95	11.24	1.59	0.76	3.49	1.53	2.15	0.77	0.27	0.00	2.42
Samoa	43.65	24.32	7.76	2.99	4.56	2.36	0.79	0.97	1.42	1.24	0.25
Tonga	12.27	8.61	0.92	0.68	0.18	1.71	0.57	1.30	1.03	0.49	0.03
Tuvalu	77.66	32.35	26.69	14.58	10.66	0.84	7.67	3.63	1.29	1.55	6.80

Regional differences in catch composition do not necessarily reflect the availability of fish. Rather, comparisons of the relative importance of the main fish families in catches, with estimates of their average biomass from underwater visual census, show that emperors, groupers, parrotfish and surgeonfish are differentially selected among countries (Table 1.4). This selection is likely to be influenced by regional variation in fishing techniques, and preferences for different fish as food.

Most demersal fisheries are characterised by small-scale, relatively low-cost, fishing methods.[56] A considerable amount of fishing takes place from the shore or in shallow waters without the use of fishing vessels. Where fishing vessels are used, these are generally small canoes and dinghies powered by outboard motors or sails. The fishing methods used to catch demersal fish in the tropical Pacific are diverse. They include handlines, gillnets, spearguns and handheld spears, cast and scoop nets, and mobile and permanent artisanal fish traps. Handlines are used more frequently in Melanesia than in Micronesia and Polynesia, whereas use of hand spears, spearguns and gillnets is widespread. The fishing method influences the range of species caught, as well as the impact of fishing on the habitat. Further details about the fishing methods used in demersal fisheries are provided in **Appendix 1-C**.

A ''typical'' small-scale, commercial coral reef fishery in the western and central areas of the region harvests between 200 and 300 finfish species, although it is likely that only a relatively low proportion of these species dominate landings.[57,58,59,60]

1.3.2.2 Nearshore pelagic fisheries

These fisheries target tuna and the other large pelagic fish described above in nearshore waters and contribute significantly to local fish supply, often through sales to rural and urban markets. There is a lack of reliable catch data for these fisheries[61], however, total production across the participating countries is estimated to be ca. 40,000 tonnes per year. In contrast to demersal fisheries, nearshore pelagic fisheries targeting tuna and tuna-like species usually depend on the use of boats suitable for operating several kilometres out to sea. The main fishing methods used are trolling and mid-water techniques, such as vertical longlines and mid-water handlines. These methods are enhanced when used close to fish aggregating devices (FADs) anchored in these nearshore waters.[62,63] There is potential to increase the catch of nearshore pelagic species, with the result that pressure on demersal reef-associated species harvested for subsistence and commercial purposes could be reduced where necessary.[64,65] The fish species targeted by nearshore pelagic fisheries are expected to be relatively insensitive to changes in the condition of coastal habitats.

1.3.2.3 Invertebrate fisheries

Invertebrate fisheries also make significant contributions to the food supply, livelihoods and local culture in both rural communities and urban populations.[66,67] The most widespread activity within the invertebrate fisheries in the region involves the subsistence hand gathering (gleaning) of the wide range of molluscs, echinoderms, crustaceans and polychaetes mentioned earlier. Indeed, more than 350 species of invertebrates were recorded in local fisheries by SPC's ProcFish Project during its survey of 63 sites across 17 Pacific Island countries and territories between 2002 and 2009.[68]

The invertebrate fisheries in participating countries also include collection species for export. In addition to the sea cucumbers (bêche-de-mer), and trochus, green snail and pearl oysters for mother-of pearl mentioned above, the invertebrate export trade also includes live molluscs (such as cultured giant clams), crustaceans and corals for the ornamental aquarium industry. Fisheries for beche-de-mer, trochus and green snail have generally been ''boom-bust'' fisheries, characterised by a relatively short period of large harvests followed by long periods of low or zero production due to resource depletion.[69] Further details on export of trochus and sea cucumbers are provided in **Appendix 1-C.**

1.3.3 Industrial tuna fisheries[70]

Fishing for tuna plays an important role in the economies of all countries participating in the RTP. However, the contributions of tuna to the economies of nine countries are so substantial that they are now referred to as ‘tuna-dependent’.[71]

The industrial tuna fisheries in the EEZs of PICs are based on the use of large vessels with much of the catch marketed by multinational fish-trading corporations. The largest of the two main fisheries is commonly referred to as the ‘surface fishery’, where purse-seine and pole-and-line vessels target schools of skipjack tuna, and the smaller size classes (< 80 cm) of yellowfin tuna, in the equatorial regions of the WCPO. The catch from the surface fishery is used for canning. Many purse-seine vessels often deploy large numbers (100-200) of drifting FADs to help concentrate and capture the surface-schooling tuna (primarily skipjack, sub-adult yellowfin and bigeye). The surface fishery also involves some pole-and-line vessels.

The second of the two main industrial tuna fisheries is undertaken by longline vessels that target mature bigeye and yellowfin tuna in equatorial waters for the Japanese sashimi trade and other high-value markets. In southern subtropical waters, the longline fishery catches mainly South Pacific albacore for canning, but also a proportion of high-value adult yellowfin and bigeye tuna.

Further information of the tuna species targeted by industrial fisheries in the WCPO is provided in **Appendix 1-D.**

The fleets engaged in the surface and longline fisheries are a mix of domestic vessels from PICs and those from the main distant water fishing nations (Japan, Korea, China, USA and the EU).

1.4 Recent catch history

1.4.1 Coastal fisheries

Estimating coastal fisheries production in Pacific Island countries has been challenging due to the large number of species involved (**Appendix 1-C**) and the fact that much of the fish is used for subsistence in remote locations. Nevertheless, a series of three ‘Benefish’ reports synthesised the disparate available data, including information from household income and expenditure surveys (HIES),[72] to produce estimates of total coastal fisheries production every seven years between 2007 and 2021.[73,74,75] These reports were limited to estimating two categories of coastal fisheries production – subsistence and commercial catch.

The three reports confirm that subsistence fishing accounts for a much larger proportion (~70%) of coastal fisheries production than small-scale commercial fishing, and that this pattern has been consistent between 2007 and 2021 (Table 1.5). This general pattern is also observed in most of the 14 countries participating in the RTP (Figure 1.5).

Table 1.5. Contributions (in tonnes) of subsistence and commercial fishing to total coastal fish catch in the Pacific Island region from 2007 to 2021.

Year	Subsistence catch	Commercial catch	Total coastal catch
2007	109,933	44,789	154,722
2014	110,183	53,753	163,936
2021	123, 961	50,123	174,084

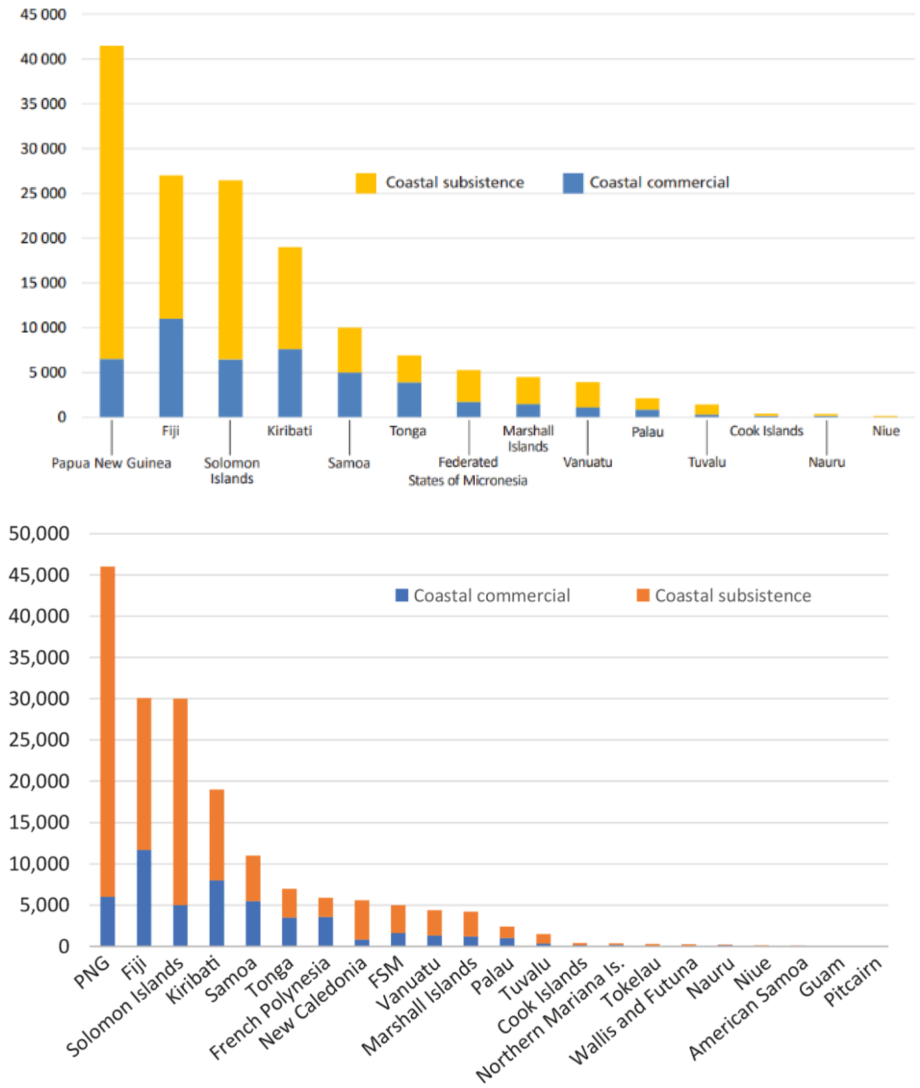

Figure 0.5 Estimates (in tonnes) of subsistence and commercial coastal fisheries production in 2014 (top) and 2021 (bottom) in Pacific Island countries and territories.[76,77]

However, limiting the analysis of coastal fish catch to the relative production by the subsistence and commercial sectors does not enable evaluation of differences in productivity of the three main types of fisheries (demersal, nearshore pelagic and invertebrate) described in Section 1.3.2. This is a major impediment to understanding the contribution of these three fisheries to food security and livelihoods, and to measuring the success of management measures to optimise the benefits from the resources supporting the three types of coastal fisheries.[78]

To address this challenge, SPC and partners used a procedure to disaggregate the estimates of national subsistence and commercial catches in 2007 into pelagic, demersal and invertebrate categories,[79] (Table 1.6), and then used the same technique again with the 2014 catch data.[80] In addition, surveys conducted by the SPC PROCFish Project also provide information on the status of important families of demersal fish, and invertebrates, across the majority of Pacific Island countries (Table 1.4).[81]

This approach has enabled changes in the composition of the main categories of coastal fisheries production to be estimated in a more meaningful way (Figure 1.6). It also provides a basic framework for an initial analysis of the projected effects of climate change on coastal fisheries production (see Chapter 2).

In the near future, the use of AI promises to revolutionise the ability of Pacific Island countries to assess and monitor coastal fish catches with accuracy and precision. [82]

Table 0.6. Annual estimated catches (in tonnes), and as a percentage of total catch, for the different categories of coastal fisheries in the participating countries (note catch for the invertebrate fishery is split into two different groups in this table but is treated as a single fishery elsewhere in the text).[83]

GCF Participating Country	Demersal fish		Near shore pelagic fish		Targeted invertebrates		Sub/intertidal invertebrates		Total catch
	tonnes	%	tonnes	%	tonnes	%	tonnes	%	tonnes
Melanesia									
Fiji	17,450	64.9	5270[a]	19.6	630	2.3	3550	13.2	26,900
PNG	14,520	40.7	13,760[a]	38.6	1300[f]	3.6	6120	17.1	35,700
Solomon Islands	8925	48.9	5750[a]	31.5	950	5.2	2625	14.4	18,250
Vanuatu	1730	51.3	753[a]	22.4	70	2.1	815	24.2	3368
Micronesia									
FSM	6290	49.9	3560[b]	28.3	30	0.2	2720	21.6	12,600
Kiribati	15075	72.8	4250[c]	20.5	60	0.3	1315	6.4	20,700
Marshall Islands	2417	64.4	1080[a]	28.8	3	0.1	250	6.7	3750
Nauru	310	47.7	310[c]	47.7	0	0.0	30	4.6	650
Palau	950	44.9	680[a]	32.2	100	4.7	385	18.2	2115
Polynesia									
Cook Islands	146	36.5	240[c]	60.0	0	0.0	14	3.5	400
Niue	62	41.3	75[a]	50.0	0	0.0	13	8.7	150
Samoa	4419	51.2	2550[b]	29.6	0	0.0	1655	19.2	8624
Tonga	5245	80.7	650[b]	10.0	0	0.0	605	9.3	6500
Tuvalu	837	68.9	326[b]	26.8	0	0.0	52	4.3	1215

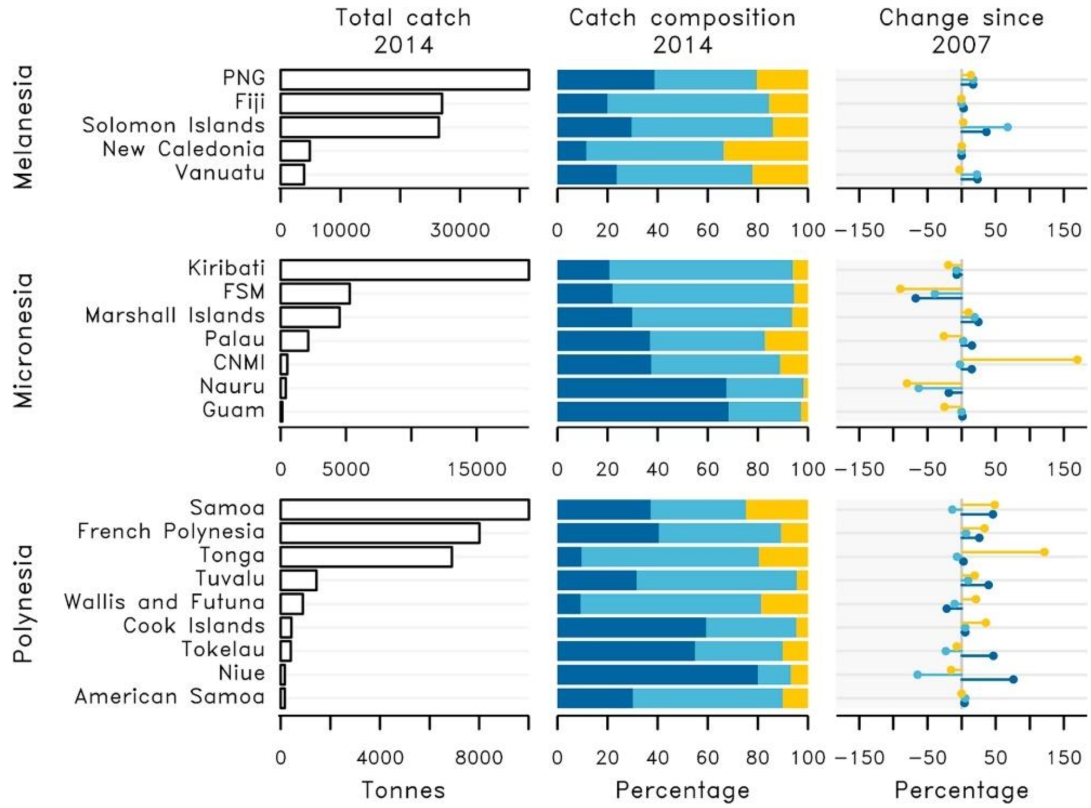

Figure 0.6. Total coastal fisheries catch (tonnes) estimates for Pacific Island countries and territories (PICTs) in 2014 (left), together with the estimated percentage of demersal fish (▪), nearshore pelagic fish (▪) and invertebrates (▪) comprising the total catch in 2014 (centre) and the percentage change in each catch component between 2014 and 2007 (right).[84] Note differences in scale for total catch between PICTs in Melanesia, Micronesia and Polynesia.

1.4.2 Industrial tuna fisheries[104]

The total tuna catch from the WCPO for 2022 was estimated at ~2,700,000 tonnes (t), with purse-seine fishing accounting for ~1,900,000 t (70% of the total catch), longline taking ~230,000 t (9%) and pole-and-line ~170,000 t (6%), (Figure 1.7 and Figure 1.8).[85] The remainder of the catch (15%) in 2022 was taken by troll gear and a variety of artisanal gears, mostly in Indonesia and the Philippines.

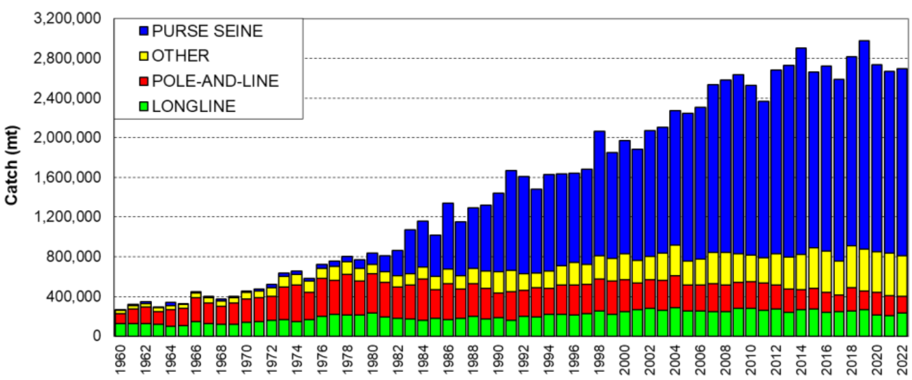

Figure 0.7 Catch (tonnes) of target tunas in the Western and Central Pacific Ocean, by purse seine, longline and pole-and-line, and other gear types (1990-2022).

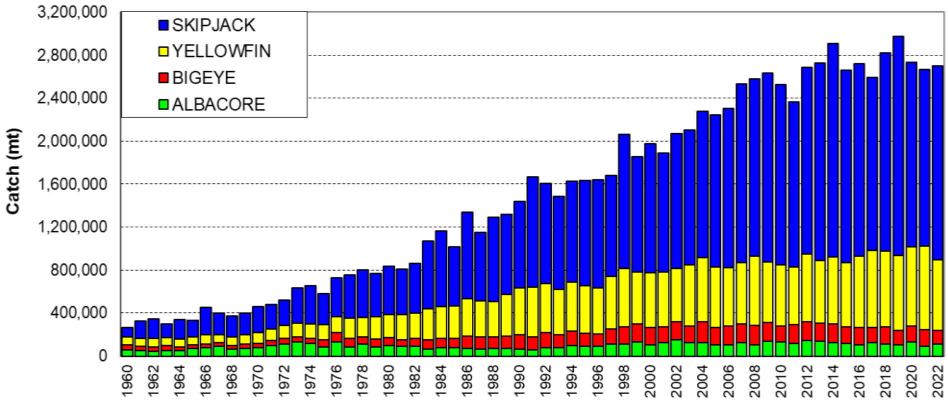

Figure 0.8 Total annual catch (tonnes) of skipjack, yellowfin, bigeye and albacore tuna from the Western and Central Pacific Ocean for the period 1990-2022.

More than 95% of all tuna caught from the jurisdictions of the 22 Pacific Island countries and territories comes from the combined EEZs of the nine tuna-dependent countries participating in the RTP. The catch from the EEZs of the 14 participating countries accounts for ~50% of the total WCPO annual catch (Table 1.7). The WCPO tuna catch for 2022 represented 80% of the total Pacific Ocean tuna catch and 54% of the global tuna catch. Unlike other oceans, more than 85% of the WCPO tuna catch was taken in the waters of the coastal states (EEZs and archipelagic waters) (Figure 1.9).

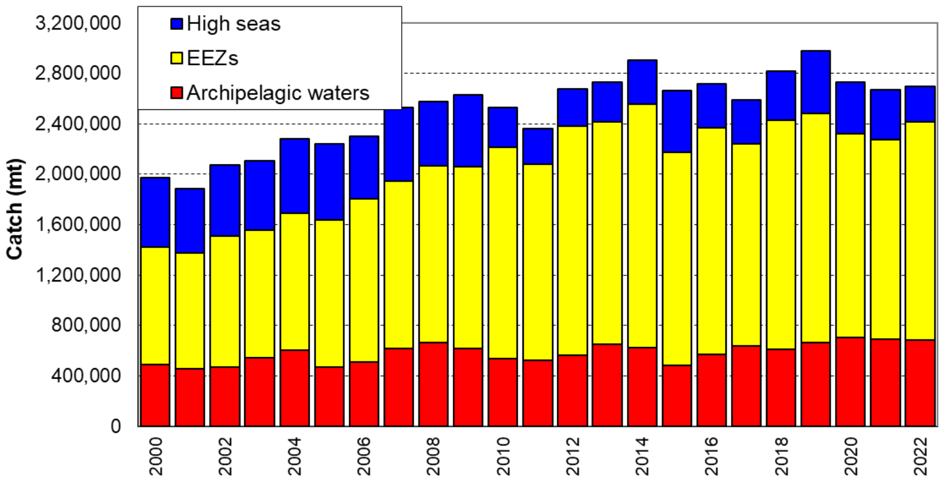

Figure 0.9 Estimates of total tuna catch (tonnes) from the Western and Central Pacific Ocean by archipelagic waters (AWs), national waters (exclusive economic zones, excluding AWs) for all Pacific Island countries and territories, and high seas areas for the period 2000 to 2022.

Access fees paid by industrial fishing fleets to fish within these EEZs provide an average of 32% (range = 4−70%) of the government revenue (excluding grants) of the nine tuna-dependent countries. These extraordinary benefits have been secured mainly through cooperative management of the purse-seine fishery within the combined EEZs of eight of these countries, known as the Parties to the Nauru Agreement (PNA), via their 'Vessel Day Scheme' (see Chapter 2 for details). The longline and pole-and-line fishing operations that occur within the waters of tuna-dependent Pacific Island countries generally make minor contributions to these economies compared with purse-seine fishing.

Table 0.7. Annual reported total catch (in tonnes) for target tuna species (skipjack, yellowfin, bigeye and albacore), by all fishing methods, from the exclusive economic zones (EEZs) of the participating countries from 2012 to 2022. The percentage of the total regional tuna catch taken from each EEZ is also shown.[86] For Kiribati, data are presented for the nation's three separate EEZ areas combined.

Country	Year										
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Cook Is	31,027	17,075	20,740	24,648	13,835	24,305	39,942	36,077	16,466	6,189	8,650
Fiji	7,041	5,631	7,781	12,384	11,111	12,604	9,211	9,278	8,415	7,082	8,199
FSM	189,236	219,289	143,363	167,375	202,364	196,015	297,464	171,735	203,544	119,830	246,290
Kiribati	126,917	108,799	298,324	327,660	81,372	123,747	117,815	129,680	86,352	46,442	45,984
Marshall Is	35,063	47,530	88,552	36,564	90,734	34,773	36,170	13,637	47,005	65,018	45,196
Nauru	51,941	166,017	188,878	69,069	116,299	83,379	170,619	105,849	137,921	151,520	79,587
Niue	-	420	282	270	105	18	423	468	226	25	2
PNG	730,811	732,435	447,914	247,806	427,181	508,586	444,745	437,453	606,657	561,059	798,296
Palau	3,925	3,209	4,904	1,574	5,996	17,603	9,462	6,602	882	502	790
Solomon Is	120,531	151,116	115,869	150,866	190,212	194,156	115,616	97,329	128,972	146,545	199,936
Tonga	1,345	2,346	743	1,725	2,792	1,885	1,158	1,989	1,630	1,631	15,321
Tuvalu	72,594	57,518	99,804	77,647	127,303	58,042	91,738	121,723	90,135	79,064	59,514
Vanuatu	6,174	8,441	8,489	7,657	10,132	11,461	7,017	4,235	6,776	2,434	5,826
Samoa	3,493	2,048	1,453	2,330	3,531	2,435	1,843	1,882	1,817	1,288	1,015
Total	1,376,605	1,521,874	1,427,096	1,127,575	1,282,967	1,269,009	1,343,223	1,137,937	1,336,798	1,188,629	1,514,606
WCPO Total	2,683,005	2,729,689	2,905,962	2,662,135	2,720,548	2,590,938	2,818,629	2,986,743	2,703,227	2,635,291	2,701,239
Percentage	51	56	49	42	47	49	48	38	49	45	56

Together, the four target tuna species represent > 90% of the total catch taken by industrial fleets. The remainder of the catch is comprised predominately of billfish (marlin and swordfish), oceanic sharks and the North Pacific catch of Pacific bluefin tuna. Further details of the production of the industrial tuna fisheries in the WCPO are provided in **Appendix 1-E**.

1.5 Status of marine fish stocks

1.5.1 Coastal fisheries

Improvements in coastal fishing methods (e.g., more widespread use of GPS, outboard motors, monofilament nets and lines), in combination with population growth, has led to declines in stocks of targeted coastal fish species in several locations across the region.[87] Examples include coral reef and lagoon fish stocks in Palau[88] and Kiribati,[89] bonefish, milkfish and parrotfish in the Cook Islands,[90] larger groupers and snappers in Fiji[91] and reef and small pelagic fishes in Samoa.[92]

In addition to appropriate limits on catch, sustainability of coastal fisheries also depends on maintenance of the extent and quality of essential coastal fish habitats. As mentioned in Section 1.2.2.2, many coastal fish and invertebrates are associated with specific habitat types (e.g., coral reefs, seagrasses and mangroves), and fish and invertebrate populations decline in abundance following the degradation or loss of those habitats associated with increases in human population densities,[93,94,95] compounding the impacts of overfishing. This is discussed in more detail in Technical Study 1 in Annex 26.[96]

Another important consideration in assessing the status of fisheries for demersal fish is the extent to which fishing is concentrated on different species, especially those considered to play an important role in maintaining the resilience of coral reefs. Foremost among functionally important reef fish are the herbivorous species that keep reefs relatively free of macroalgae, which facilitates the settlement and growth of habitat-forming corals. The role of these fish is especially important given the increasing incidence of coral loss due to environmental perturbations, including climate change.[97] Over-exploitation of herbivorous fish is not only a cause for concern because species like parrotfish, surgeonfish and rabbitfish comprise a large proportion of the catch in the participating countries (Table 1.3), it may also lead to a 'phase-shift',[98] where reef habitats become dominated by macroalgae, threatening the status of other reef-associated fish.[99]

Although the status of demersal fish stocks throughout much of the tropical Pacific is poorly known because of the lack of long-term catch records on which to base assessments (Section 1.4.1), two bodies of work indicate that, away from urban centres, fisheries exploitation is relatively low within most PICs compared with other parts of the world.

One of these investigations[100] converted estimated national fish catches in 2007 (Section 1.4.1.) to production per area and compared them to biomass estimates per area from underwater visual surveys of coral reef fish. This assessment showed that the majority of PICs are harvesting < 2 tonnes of seafood per km^2 per year from coastal habitats, compared to biomass estimates of commonly caught species in the range of 50 to 250 tonnes per km^2, based on underwater visual surveys at 4 to 5 coral reef sites in each of 17 countries and territories in the region.[101] This assessment concluded that coral reef habitats in the Pacific Island region can generally be expected to yield 3 tonnes of demersal fish per km^2 of reef habitat per year, in line with the median yield from a diverse range of multi-species coral reef fisheries worldwide.[102]

Further details of this assessment of the status of commonly-caught demersal fish in 17 countries and territories is presented in Figure 1.10**.** Catch rates at 38% of the 63 sites surveyed were estimated to be poor to medium, even though the current fishing pressure was low. Such sites appear to have limited potential to produce fish or productivity may have already been compromised by historical overfishing and/or habitat degradation. Another 25% of sites were in more serious trouble – the status of demersal fish resources was poor to medium, and they were subject to high fishing pressure. Demersal fish resources at another 17% of sites had medium to good status but fishing pressure was high and unsustainable. Only 19% of sites had medium to good resource status and low fishing pressure.

The second body of work found that localised coral reef and lagoon fishery yields in excess of 20 t/km^2/yr are not uncommon in the Pacific and South-east Asia,[103] but acknowledged that the estimates of reef fishery yields were complicated by being inversely proportional to the area of reef being studied, and by the inclusion of catches from adjacent habitats such as the lagoon, mangroves and outer reef slope.[104]

Using a simple surplus production model and data from coral reef fisheries in Melanesia, Micronesia and Polynesia, sustainable yields of between 4 and 22 t/km^2/yr have been estimated noting that fishing pressure on Pacific Island coral reefs and lagoons is largely a function of adjacent human population density.[105] These analyses are now rather dated and ignore the long-term effects of heavy fishing pressure on reef fish communities, potential under-estimates associated with subsistence fishing, and the possibility that high yields may be the result of a shift from highly-valued, large, long-lived reef fishes to higher volumes of the more resilient, smaller, faster growing species that are lower in value.[106]

The status of nearshore pelagic species such as Spanish mackerel, barracuda, rainbow runner and neritic tunas, and the invertebrates harvested commonly in PICs, is largely unknown because catch data and knowledge of the population biology and regional abundance of these species are limited.

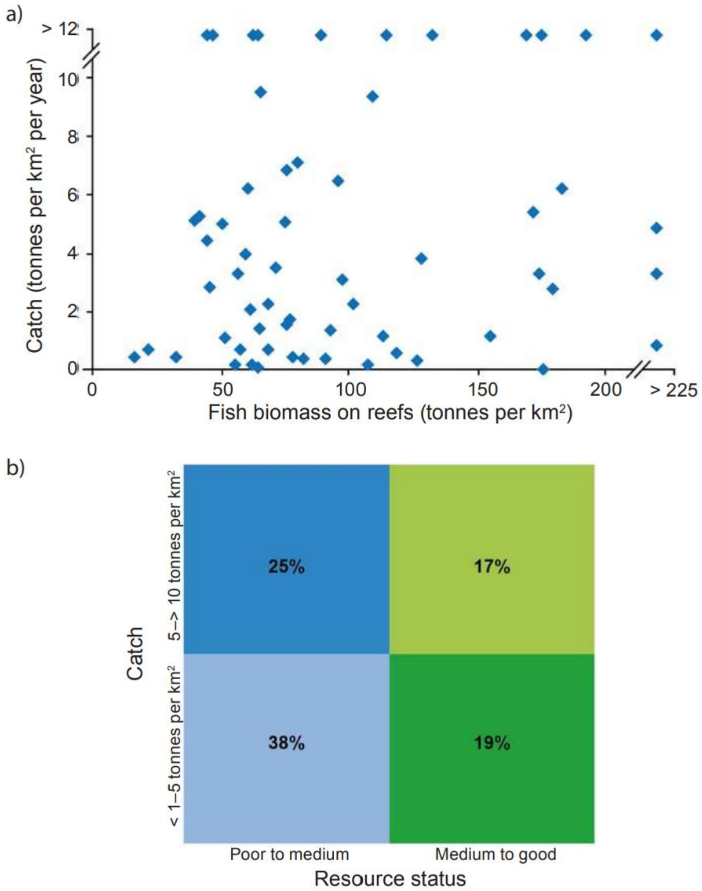

Figure 0.10. Relationships between the status and catches of demersal fish. Summarised for 63 sites in 17 Pacific Island countries and territories for the 11 families of fish based on (a) estimates of fish biomass from underwater visual surveys and socioeconomic surveys of adjacent fishing communities; and (b) a more integrated approach to assessing resource status, which combines features of the fish community (size composition from size spectra slopes, differences between cumulative biomass and density dominance curves, relative density of large species, relative biomass of small fish and piscivores, and the ratio of herbivores to carnivores) and site quality (distance from centre of biodiversity, number of reef types, and proportion of the outer-reef surface area).[107,108]

1.5.2 Industrial tuna fisheries[109]

1.5.2.1 Skipjack tuna

The most recent (2022) stock assessment of skipjack tuna, the species that dominates purse-seine catches in the WCPO (Figure 1.8), commissioned by WCPFC indicated that the stock is not overfished, nor undergoing overfishing.[110]

Although the 2022 stock assessment indicates that fishing mortality for skipjack tuna has increased over time, current fishing mortality rates are estimated to be only about 0.32 times the level of fishing mortality associated with maximum sustainable yield (F_{MSY}). Therefore, overfishing is not occurring (i.e. $F_{recent} < F_{MSY}$). Median spawning biomass is estimated to be at 51% of the level predicted in the absence of fishing, well above the harvest strategy limit reference point (LRP) of 20% the level predicted in the absence of fishing ($SB/SB_{F=0} > 0.2$).

Under status quo fishing conditions, where catch and effort levels are maintained at the average 2018–2021 levels, the stock is projected to have zero probability of dropping below the LRP.

Graphs illustrating exploitation history, present stock status and future projections for skipjack tuna are shown in Figure 1.11.

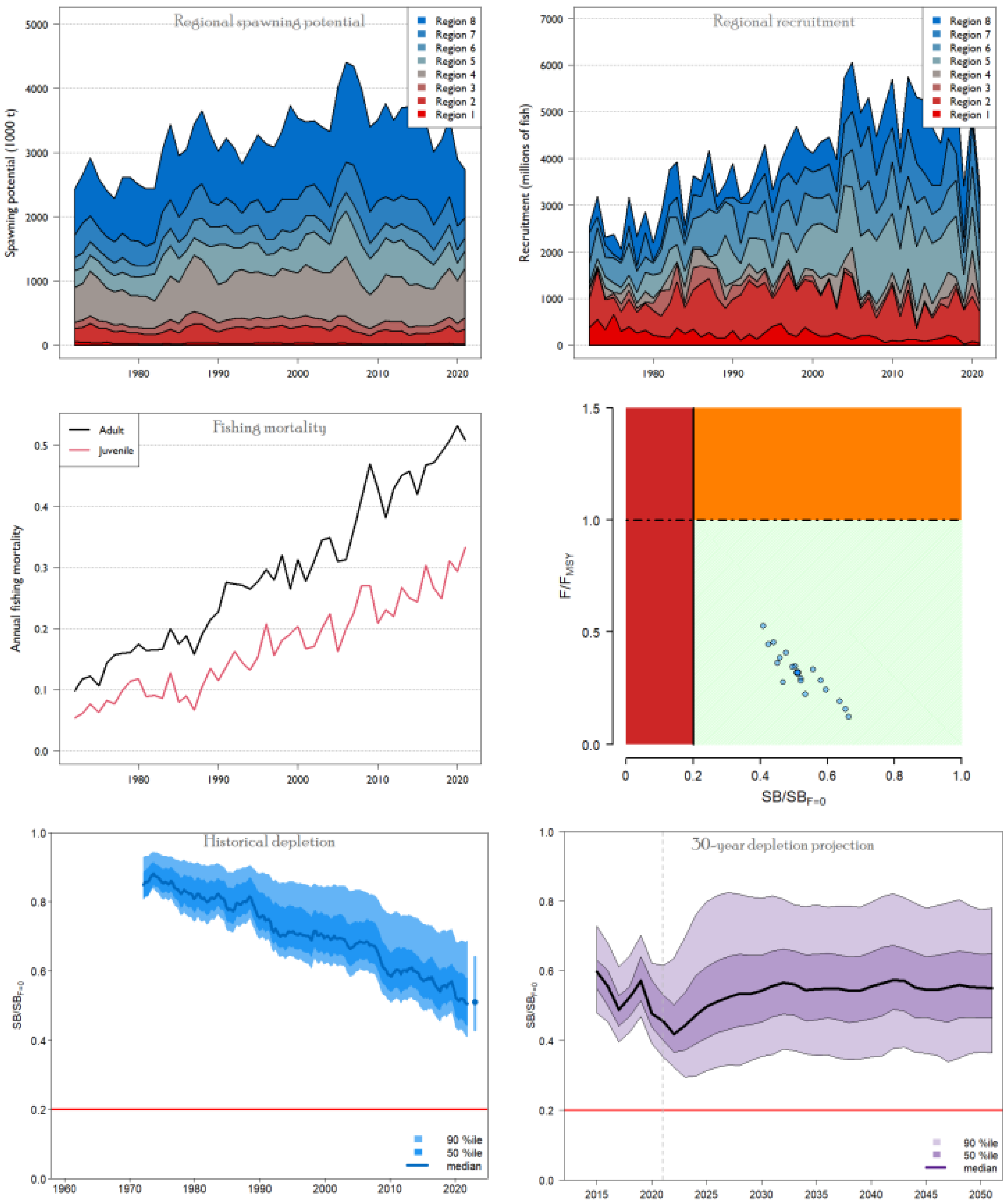

Figure 0.11. Exploitation history, present status and future projections for skipjack tuna. Estimated spawning biomass (SB) time-series by model region (top left), recruitment by model region (top right), and fishing mortality for adults and juveniles (middle left) from the skipjack diagnostic case model; stock status displayed on a Majuro plot as the end points (recent values) from the uncertainty grid of 18 models (middle right) with the weighted median value illustrated by the large blue point; the estimated level of depletion across the grid (bottom left), and 30-year projected depletion based on actual fishing levels until 2021 (bottom right).

1.5.2.2 Yellowfin tuna

The most recent assessment of yellowfin tuna in the WCPO was conducted in 2020[111] and included data from 1952 to 2018. It shows that fishing mortality on both juvenile and adult fish has increased steadily since the early years of the fishery, although juvenile mortality shows signs of levelling off in recent years. Current fishing mortality rates for yellowfin tuna, however, are estimated to be below the level associated with maximum sustainable yield ($F_{MSY)}$), which indicates that overfishing is not occurring.

Spawning biomass showed a continuous decline from the 1950s to the 2000s but appears to have levelled off after 2010. Consistent with this trend in spawning biomass, absolute recruitment has been variable throughout the assessment period, but somewhat lower in the past three decades relative to the 1950s and 1960s.

Recent spawning biomass levels are uniformly estimated to be above the SB_{MSY} level, and the limit reference point of 20% of the level predicted in the absence of fishing. Under status quo fishing conditions, where effort and catch levels are maintained at the average 2016–2018 levels, the stock is projected to have zero probability of dropping below the LRP.

Graphs illustrating the exploitation history, present stock status and future projections for yellowfin tuna are shown in Figure 1.12.

1.5.2.3 Bigeye tuna

The most recent assessment of bigeye tuna in the WCPO was conducted in 2020.[112] This assessment used otolith-based growth estimates, first introduced in the 2017 assessment,[113] and incorporated additional age–length data from otolith readings as well as length increment data from tag recaptures. Additionally, only the 10°N spatial structure was considered.

Fishing mortality is estimated to have increased over time, particularly on juveniles over the last five decades, although juvenile mortality shows signs of levelling off in recent years. Current fishing mortality rates for bigeye tuna, however, are estimated to be below F_{MSY}, indicating that overfishing is not occurring. Spawning biomass shows a long continuous decline from the 1950s to the 2000s but appears to have levelled off since around 2010, and is till estimated to be above both the SB_{MSY} level and the LRP of 20% of the level predicted in the absence of fishing.

Under status quo fishing conditions, where effort and catch levels are maintained at the average 2016–2018 levels and the relatively positive recent (2007–2016) recruitment patterns are assumed to continue, the stock is projected to have zero probability of dropping below the LRP.

Graphs illustrating exploitation history, present stock status and future projections for bigeye tuna are shown in Figure 1.13.

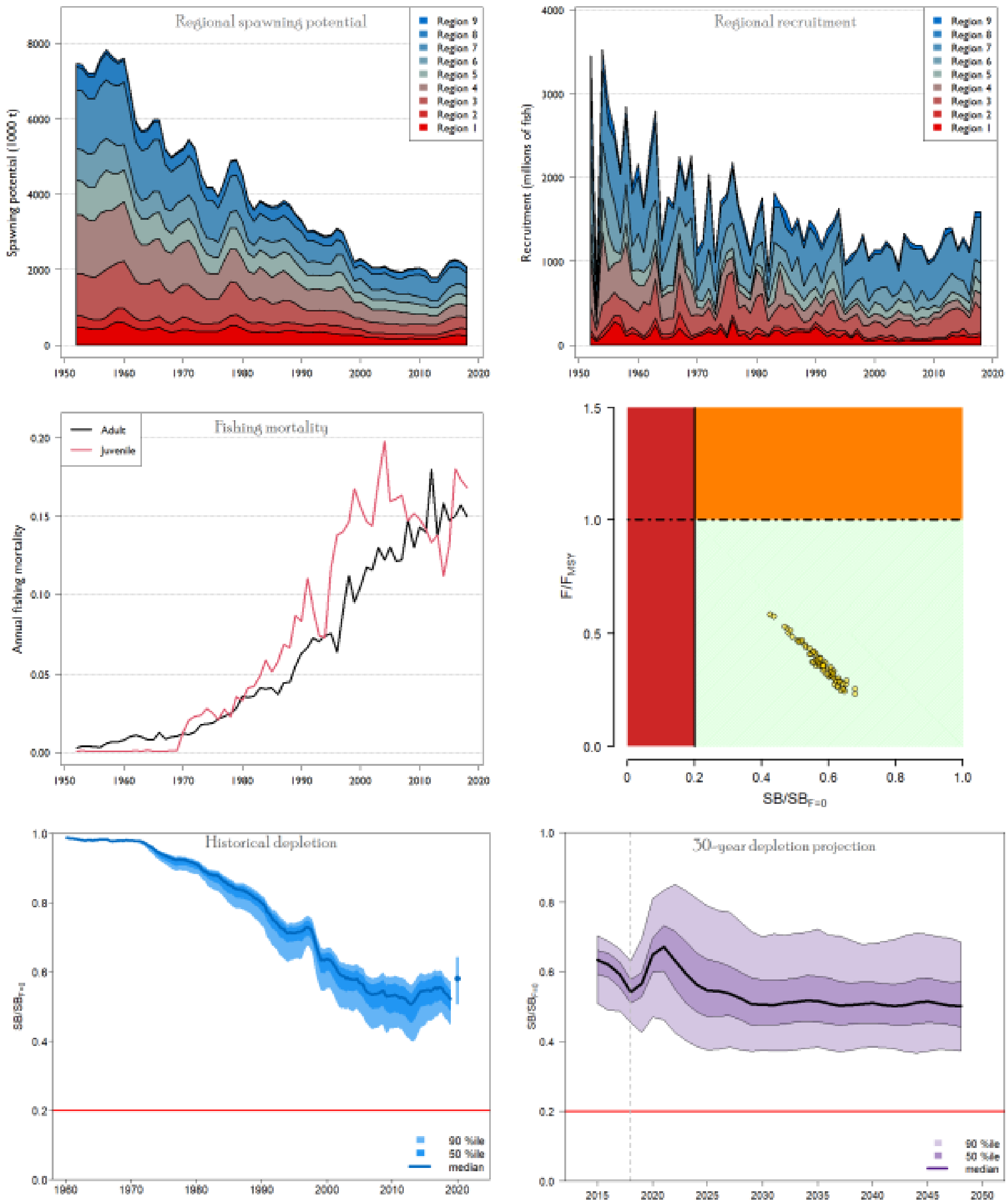

Figure 0.12. Exploitation history, present status and future projections for yellowfin tuna. Estimated spawning biomass (SB) time series by model region (top left), recruitment by model region (top right), and fishing mortality for adults and juveniles (middle left) from the yellowfin diagnostic case model; stock status displayed on a Majuro Plot as the end points (recent values) from the uncertainty grid of 72 models (middle right) with the weighted median value illustrated by the large yellow point; the estimated level of depletion across the grid (bottom left), and 30-year projected depletion based on actual catch/effort levels through 2021, and assuming 2021 fishing catch/effort levels afterwards (bottom right).

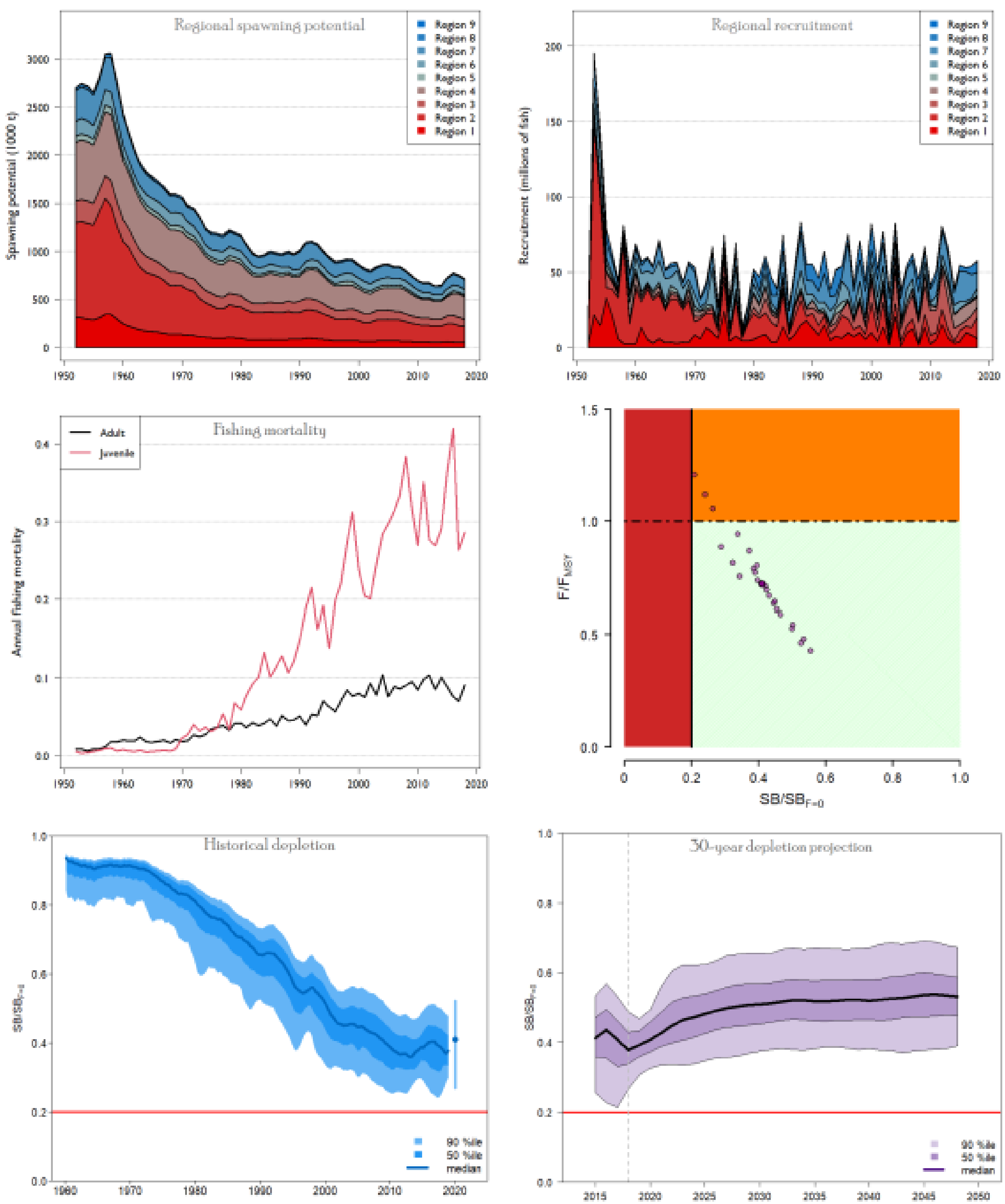

Figure 0.13. Exploitation history, present status and future projections for bigeye tuna. Estimated spawning biomass (SB) time series by model region (top left), recruitment by model region (top right), and fishing mortality for adults and juveniles (middle left) from the bigeye diagnostic case model; stock status displayed on a Majuro plot as the end points (recent values) from the uncertainty grid of 24 models (middle right) with the weighted median value illustrated by the large purple point; the estimated level of depletion across the grid (bottom left), and 30-year projected depletion, under the “recent recruitment” (2007–2016) assumption, based on actual catch/effort levels through 2021, and assuming 2021 fishing catch/effort levels afterwards (bottom right).

1.5.2.4 South Pacific albacore

The most recent stock assessment for South Pacific albacore tuna was undertaken in 2021.[114] Unlike the previous assessment that only considered the WCPFC-Convention Area (CA),[115] the 2021 assessment included the entire South Pacific region (south of the equator) incorporating the convention areas of both the WCPFC and the Inter-American Tropical Tuna Commission (IATTC) in the Eastern Pacific Ocean. The assessment was a collaborative effort by scientists from the Oceanic Fisheries Programme at the Pacific at SPC and IATTC scientists; data covered the period 1960 to 2019. Management advice was provided for the entire South Pacific region, and for the WCPFC and IATTC convention areas separately.

The South Pacific–wide assessment indicated the spawning biomass has continued to become more depleted during the period 1960–2019, and more so in the most recent years. However, the stock is not considered to be overfished, and there was zero estimated risk of the stock being below the LRP of 20% $SB_{F=0}$.

Due to the decline in stock status estimated over the last several years, the $SB_{latest}/SB_{F=0}$ (year 2019; median 0.40; range 0.25–0.46) is more pessimistic than the $SB_{recent}/SB_{F=0}$ (years 2016–2019; median 0.52; range 0.37–0.59).

Fishing mortality has generally been increasing over time, most notably for the adult component of the stock. The median F_{recent} (2015–2018 average) was estimated to be 0.24 times the fishing mortality that would support MSY (range 0.13–0.47). Similarly, median SB_{recent}/SB_{MSY} was estimated at 3.22 (range 2.07–5.33). These estimates indicate that, according to WCPFC reference points, the stock is not overfished or currently undergoing overfishing.

The addition of the IATTC region into the South Pacific albacore assessment did not notably alter the main assessment outcomes, and similar trajectories and terminal depletion levels were estimated in both the WCPFC and IATTC convention areas. Under status quo fishing conditions, where catch levels are maintained at recent 2020 levels, the stock is projected to decline further in the short term but equilibrate over the long-term at a median depletion ($SB/SB_{F=0}$) of 0.47, with 19% risk of being below the LRP of 20% $SB_{F=0}$ and 17% risk of F being greater than F_{MSY} at the end of the 30-year projection period.

The 2021 WCPFC Scientific Committee expressed concern that the projections suggest the current catch levels will produce a notable risk of the stock breaching the LRP. Results of catch–based projections were similar for the WCPFC and IATTC convention areas.

Graphs illustrating the exploitation history, present stock status and future projections for South Pacific albacore are shown in Figure 1.14.

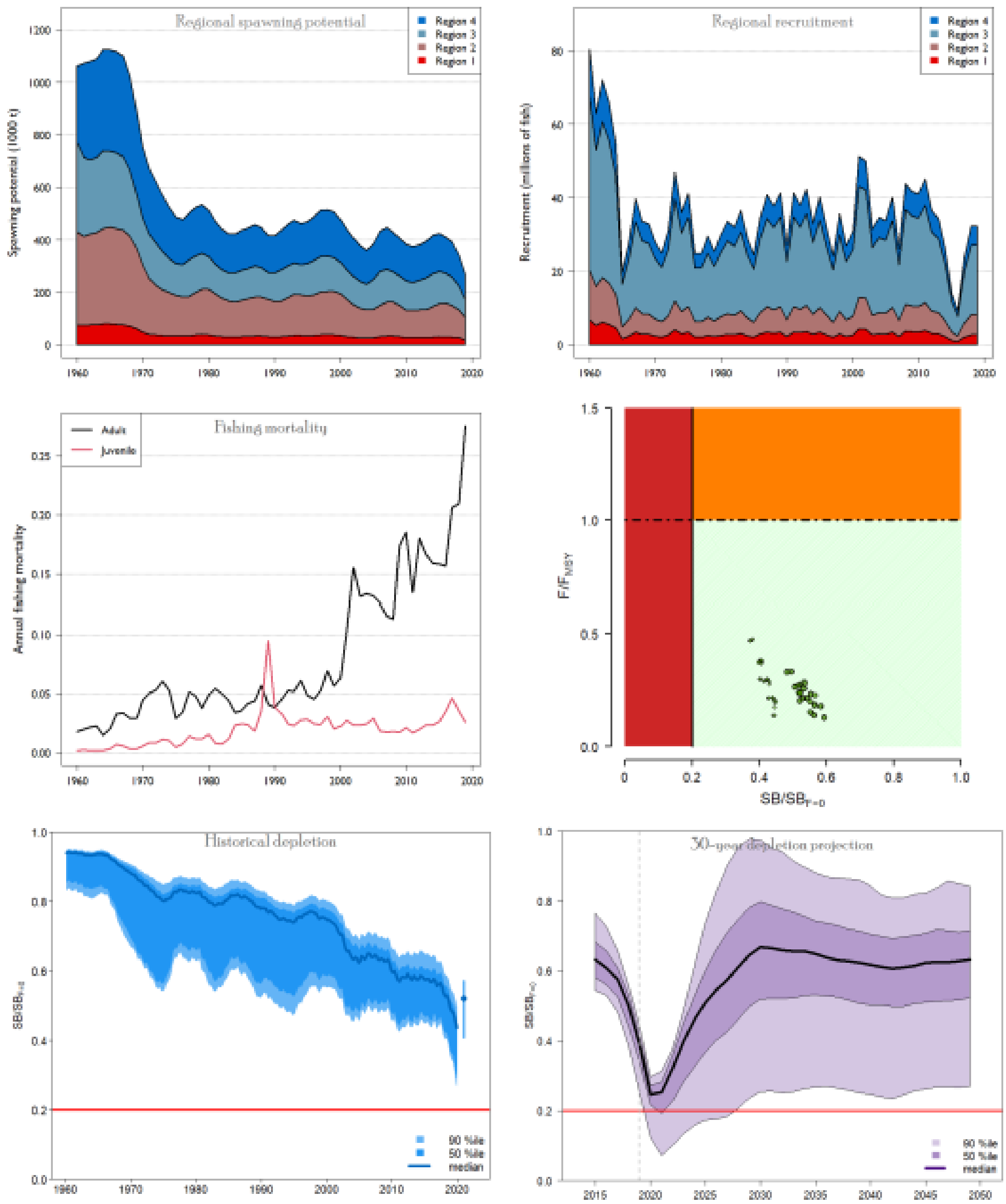

Figure 0.14. Exploitation history, present status and future projections for South Pacific albacore tuna. Estimated spawning biomass (SB) time series by model region (top left), recruitment by model region (top right), and fishing mortality for adults and juveniles (middle left) from the albacore diagnostic case model; stock status displayed on a Majuro plot as the end points (recent values) from the uncertainty grid of 72 models (middle right) with the smallest dots indicating the down weighted SEAPODYM movement hypothesis and the single large green point is the weighted median value; the estimated level of depletion across the grid (bottom left), and 30-year projected depletion based on actual fishing levels through 2021, and assuming 2021 fishing levels afterwards (bottom right).

1.6 Socio-economic benefits of fisheries resources in the Pacific Island region

1.6.1 Importance of coastal fisheries production to nutrition of communities

Since SPC published a Policy Brief entitled 'Fish and food security' in 2008,[116] there has been a growing interest in, and understanding of, the importance of fish to the food security and public health of Pacific Island people. Recognition that solutions to the problem of staggering rates of non-communicable diseases, a key cause of death between the ages of 30 and 70 across the region,[117] has raised awareness of the vital dietary role of fish and led to plans by Pacific Island governments to provide the fish required for good nutrition.[118] These plans are based on 1) identifying how much fish people should consume to obtain recommended protein intake, 2) assessing how much fish they eat now, 3) forecasting how much fish will be needed as human populations increase and identifying any gaps in fish supply, and 4) identifying how to provide access to more fish to fill gaps in supply where shortfalls in productivity of coastal fisheries are projected to occur.[119]

This section addresses the first and second steps mentioned above. Section 1.6.2 summaries attempts to identify gaps in future fish supply for the countries participating in the RTP, and Section 1.6.3 focuses on the fourth step by considering how best to fill identified gaps in fish supply.

1.6.1.1 Recommended levels of fish consumption

The World Health Organization (WHO) recommends that daily protein intake for good nutrition should be 0.7 g of protein per kg body weight per day, derived from a variety of sources to prevent micronutrient deficiencies.[120] A study published in 2015,[121] based on the predicted age structure of populations in PICs and age-weight relationships typical of the region, average protein content of fresh fish of ~20%, and the fact that most Pacific Island people cook fish whole and eat the flesh from the head as well as the body (therefore, considered to use 80% of the weight of fish for food), estimated that average fish consumption of 35–42 kg per person per year is required to provide 40–50% of total protein intake for Pacific Island populations.[122]

Technical Study 2 in Annex 26[123] supporting the preparation of this Funding Proposal refined this approach with improved data on: the edible portion of fish, protein content of fish, average body weight of men, women and children, and their proportion on the population in each participating country. The improved analysis identified that per capita fish consumption of between 52 and 82 kg per year would be required to provide the national populations of the 14 participating countries predicted to occur in 2030 with 50% of the daily protein intake recommended by WHO.[124] The variation in required per capita consumption among the participating countries is due to the influence of ethnic origin on average body size of men and women, and differences in demography.

1.6.1.2 Estimates of fish consumption

Measuring per capita fish consumption, including canned fish, across the region has been based on the use of Household Income and Expenditure Surveys and a range of other methods (see **Appendix 1-F**). Although there are several weaknesses in the available data and methodologies, it is evident that most of the fish currently used for food in the region comes from coastal demersal fisheries around coral reefs.[125] However, canned fish also makes an important contribution to dietary protein in some countries (**Appendix 1-F**).

Data from HIES done between 2001 and 2006 were published in 2009 to quantify average national, rural and urban fish consumption per capita for 15 Pacific Island countries and territories.[126] Average national fish consumption ranged from 55 kg to 110 kg per person per year in eight of them, ~3–6 times the average global consumption of ~20 kg per person per year (Table 1.8).[127]

Analysis of data from this set of HIES also showed that fish provides 51–94% of animal protein in the diet in rural areas, and 27–83% in urban areas, across the region (Table 1.8).[128,129] PNG is the exception, where the large inland population generally has much less access to fish, except for communities living near rivers or who grow tilapia in freshwater ponds.[130] Importantly, the great majority of fish consumed in the region is derived from coastal subsistence fishing; 50 to 90% of the fish eaten in rural areas is typically caught by the household from coral reefs and other coastal habitats (Table 1.8).[131] High levels of subsistence fishing are also common in urban areas in many of the smaller PICs.

The high dependence on fish by Pacific communities is a stark contrast with average global fish consumption of fish per person, which is ~20 kg per year.[132] Due to the high dependence on fish for animal protein, and the widespread participation of households in fisheries, subsistence fishing produced three times as much fish as commercial fishing in coastal waters in 2007 (Table 1.5).

Table 0.8 Estimates of annual fish consumption (kg) per person, percentage of animal protein in the diet derived from fish, and percentage of fish consumed caught by subsistence fishing, in the 14 participating countries based on Household Income and Expenditure Surveys.[133] The amount of fish and invertebrates needed for food security in 2035 is also shown.' Blank spaces indicate that no estimate was available.

GCF Participating Countries	Fish consumption per person (kg) 2009[134]				Recent average estimate[135] 2023	Animal protein in diet (%)		Subsistence catch (%)		Fish needed for food by 2035 (tonnes)
	National	Rural	Urban	Coastal*	National	Rural	Urban	Rural	Urban	
Melanesia										
Fiji	21	25	15	113	n.a.[d]			52	7	34,200[a]
PNG	13	10	28	53	n.a.[d]			64		140,700[b]
Solomon Is	33	31	45	118	64	94	83	73	13	33,900[a]
Vanuatu	20	21	19	30	31	60	43	60	17	14,800[a]
Micronesia										
FSM	69	77	67	96	91	80	83	77	73	7300[c]
Kiribati	62	58	67	115	84	89	80	79	46	9000[c]
Marshall Is	39				91					2200[a]
Nauru	56			62	91	71	71	66	66	790[c]
Palau	33	43	28	79	102	59	47	60	35	800[a]
Polynesia										
Cook Is	35	61	25	79	36	51	27	76	27	600[a]
Niue	79	79	79	50	34			56	56	100[c]
Samoa	87	98	46	94	30			47	21	17,600[c]
Tonga	20	20	20	85	48			37	37	4000[a]
Tuvalu	110	147	69	146	55	77	41	86	56	1400[c]

* Applies to households in coastal fishing communities at > 4 sites; a = based on recommended fish consumption of 35 kg per person per year; b = based on the recent national average of 13 kg per person per year, rather than 35 kg, to reflect the difficulties of distributing fish to the large inland population; c = based on recent traditional levels of fish consumption; d. HIES data are not currently available for Fiji or PNG.

Another set of HIES undertaken between 2012 and 2020 and analysed in 2023 was included in Technical Study 2, Annex 26,[136] as part of the background research for the Funding Proposal. However, this analysis only reassessed national per capita fish consumption (Table 1.8).[137]

The average annual consumption of fish by coastal rural populations identified in the HIES data analysed in 2009 and 2023, and including data from socio-economic surveys (SES) analysed in 2009 (see **Appendix 1-F**) ranges from 30–118 kg per person in Melanesia, 62–115 kg in Micronesia, and 50–146 kg in Polynesia (Table 1.8).[138] Even in urban centres, fish consumption usually greatly exceeds the global average of ~20 kg per person per year.[139]

A 2016 review of 31 studies that investigated the role of fish in the diets of Pacific populations across the period 2004-2014 confirmed that seafood was a primary source of dietary protein.[140] Representative of the differences in these types of assessments, consumption differed across PICs, ranging from 20% of total protein intake in the Solomon Islands[141] to 37.4% in Fiji.[142, 143] The review confirmed that fish is an important staple food in most PICs, and that subsistence and commercial fishing activities make essential contributions to both household and individual food security, particularly in rural areas. The wide range of fish consumption was attributed to variables such as geographical location (rural coastal villages versus urban centres), availability of alternative animal food sources (from both agriculture and imported foods) and whether the community had a predominantly subsistence or cash-based economy.

In addition to contributing directly to subsistence needs, coastal fisheries also generate cash to buy other types of food, including canned fish.[144] This is an important consideration – it makes households more resilient by enabling them to buy food when severe weather events damage crops and prevent fishing.[145,146]

1.6.1.3 Identifying the fish required for good nutrition in the future

Two studies undertaken in the region demonstrate that many of the participating countries will face a challenge in maintaining the levels of per capita fish consumption described above by 2030 and 2050 largely due to population growth alone.

The first study was published by SPC in 2009[147], and updated in 2011[148] and 2015.[149] It demonstrated that when estimates of coastal fisheries production were integrated with projected population growth, 11 of the 14 PICs participating in the RTP would either have trouble distributing fish from remote coral reefs to urban population centres (5 countries) or a gap in fish supply needed for good nutrition of the national population (6 countries) by 2035 (Table 1.9).

The second study involves research done for Technical Study 2, and for Annex 23, to inform this Funding Proposal. Information from these analyses was used to compare the improved understanding of the per capita fish consumption required to provide 50% of recommended protein intake by the populations in the 14 participating countries (see Section 1.6.1.1) with the latest estimates of total coastal fisheries production (from demersal, nearshore pelagic and invertebrate fisheries combined),[150] and average canned tuna consumption (**Appendix 1-F**), per country to identify expected shortfalls in fish supply. Even with the incorporation of a broader range of fish supply, this study identified shortfalls in the fish required for good nutrition in eight of the 14 countries by 2030 (Table 1.10). Two of the remaining six countries (FSM and Tuvalu) were in the category where problems are expected in distributing fish from remote coral reefs to urban population centres. Overall, the results were comparable with the first study, except that more countries were expected to have a gap in fish supply and fewer were in the category of having trouble distributing fish to urban centres.

Table 0.9 Estimates of coastal fisheries production in each participating country and the fish needed to provide ~50% of recommended protein intake for the national population until 2035.

Participating Country	Area of coral reef habitat (km^2)	Coastal fish production ($tonnes.y^{-1}$)*	Fish needed for food (tonnes)			Surplus (+)/deficit (-) of coastal fish (tonnes)		
			2013	2020	2035	2013	2020	2035
Group 1: Surplus supply of reef fish								
Marshall Is	13,930	41,790	2,100	2,200	2,400	39,690	39,590	37,930
Palau	2,496	7,490	600	600	600	6,890	6,890	6,630
Cook Is	667	2,000	600	600	600	1,400	1,400	1,330
Group 2: Surplus supply of reef fish but with problems distributing this fish to urban centres								
Fiji	25,666	77,000	30,100	31,100	33,700	46,900	45,900	40,610
FSM	15,074	45,220	7,700	7,600	7,100	37,520	37,620	36,540
Tonga	5811	17,430	3,600	3,600	3,900	13,830	13,830	12,920
Tuvalu	3,175	9,530	1,200	1,300	1,500	8,330	8,230	7,700
Niue	56	170	100	100	100	70	70	60
Group 3: Deficit of reef fish								
PNG	27,086	98,760[i]	95,800	117,000	169,100	3000	-18,200	-73,800
Vanuatu	1,244	3,730	9,300	10,800	14,000	-5,570	-7,070	-10,400
Solomon Is	8,535	27,610[j]	21,400	25,400	35,600	6,210	2,210	-7,990
Samoa	465	14,000[k]	16,000	15,600	15,700	-2,000	-1,600	-2,190
Kiribati	4,320	12,960	9,700	10,900	13,400	3,260	2,060	-890
Nauru	7	130[l]	600	700	800	-470	-570	-670

*Based on the coral reef area in each country and sustainable production of 3 tonnes per km^2 of reef per year;[151] **surplus or deficit fish supply, relative to the recommended per capita fish consumption used at the time of the study, or traditionally higher levels of fish consumption.

Chapter 2 examines the increased vulnerability faced by participating countries in filling the gap in fish supply needed for good nutrition by 2050 under both a high (SSP5-8.5) and moderate (SSP2-4.5) emissions scenario.

1.6.1.4 Effective adaptations to fill the gap in fish supply

Given the projected shortfalls in fish supply identified in the studies described above, maintaining the important contributions that fish has traditionally made to the food security of coastal and urban communities in the participating countries will depend on the effectiveness of adaptations to increase access to additional sources of fish.

Based on previous work by SPC,[152,153] the most practical option involves using some of the rich tuna resources of the region to increase the availability of fish for domestic consumption by:

1) expanding the use of anchored fish aggregating devices (FADs) in nearshore waters to assist small-scale fishers to catch tuna and other large pelagic fish species for consumption by coastal communities; and

2) improving the supply and quality of bycatch (undersized tuna and other large pelagic fish) from transhipping operations by purse-seine vessels, and unloading operations by longline vessels, in Pacific Island ports for consumption by urban communities.

Table 1.10 Participating countries expected to have a gap in fish required for good nutrition in 2030, based on Table 2.8 in Chapter 2). Note that population for Papua New Guinea (PNG) is the population within 5 km of the coast.

Country	National population 2030	Coastal fish catch per year (t) 2030*	Coastal fish catch per capita per year (kg) 2030	Canned fish per capita converted to whole weight (kg)**	Total fish available per capita per year (kg)	Fish requirements per capita (kg)	Gap/surplus in fish supply per capita (kg)
Melanesia							
Fiji	920,980	26,289	29	13	42	65	-23
PNG	2,273,165	35,192	15	3	18	52	-34
Solomon Is	892,093	17,938	20	6	26	52	-26
Vanuatu	363,200	3,307	9	9	18	57	-39
Micronesia							
FSM	106,507	12,380	116	4	120	63	57
Kiribati	138,935	20,172	145	5	150	65	85
Marshall Is	53,983	3,665	68	9	77	60	17
Nauru	12,588	639	51	2	53	67	-14
Palau	17,930	2,082	116	7	123	68	55
Polynesia							
Cook Is	15,889	395	25	4	29	82	-53
Niue	1,393	148	106	14	120	80	40
Samoa	209,369	8,469	40	13	53	70	-17
Tonga	97,257	6,316	65	4	69	73	-4
Tuvalu	11,250	1,186	105	6	111	68	43

*Projected total coastal fisheries catch in 2030 under SSP5-8.5 from Technical Study 1; **From Technical Study 2 (Table 6) converted to whole weight in kg

This option promises to make the major contribution to filling the gap between the fish required for good nutrition and the fish available from sustainable coastal fisheries production in the many vulnerable countries identified in Section 1.6.1.2. However, it also includes the challenge of distributing increased volumes of tuna and associated pelagic fish among the coastal and urban communities where it is needed most, and ensuring that access to the additional fish by communities is socio-economically feasible. These challenges are addressed in Chapters 2-4.

Importantly, the percentage of the region's tuna catch needed to fill the gap in domestic fish supply is relatively small. A study by SPC and partners on behalf of all 22 Pacific Island countries and territories has shown that only ~6% of the average industrial tuna catch would be required to fill their combined gap in fish supply.[154] The proposed activities in Component A of the Funding Proposal to design and implement the option of increasing access to tuna for domestic consumption will also lay the foundation for progressive expansion of nearshore FADs as part of the national infrastructure for food security, and for continued improvements in the use of bycatch to substitute declining coral reef fish production, as the impacts of climate change continue to increase.

The importance of using tuna to fill the gap in fish supply needed for good nutrition of Pacific Island communities is highlighted by the rate at which food systems in the region are evolving.[155] Over recent decades, the food systems have been shifting from agrarian subsistence, cash crops and fishing to significantly elevated dependence on imports of staples and processed foods, particularly in urban areas. As a result, Pacific food systems are increasingly vulnerable to the effects of climate change and to exogenous events such as COVID-19 and global political and financial crises. As Pacific Island populations continue to grow, particularly in Melanesia, there is the severe risk that they will become over-dependent on imports to meet dietary needs.[156] Optimising the use of the region's rich tuna resources to fill the gap in fish supply needed to provide 50% of recommended dietary protein intake is an essential way of reducing the vulnerability of Pacific Island communities.

Another adaptation with potential to supplement diversifying the use of tuna to fill the gap in fish supply, mainly in Melanesia, is further development of freshwater pond aquaculture.[157] Although development of this type of aquaculture has yet to become economically sustainable in many areas, this option has longer-term potential to supply important quantities of fish for household nutrition in inland areas with suitable levels of rainfall. For small pond aquaculture to fulfil its potential as a well-integrated, economically viable and sustainable production system, several issues need to be overcome. These include identifying appropriate species and culture methods; reducing possible effects on freshwater biodiversity; developing cost-effective feeds based on locally available ingredients; providing incentives for investment to produce and distribute fry; and training farmers. This option has not been considered for this Funding Proposal, given it has limited potential to fill the gap in fish supply compared to increasing access to tuna.[158]

1.6.2 Contributions of tuna to employment and trade

The tuna fisheries of the WCPO and associated industries make significant contributions to government revenue, employment, and exports in nine of the 14 countries participating in the RTP. The Pacific Island Forum Fisheries Agency (FFA) prepares a regular update of the economic contribution of regional tuna fisheries to its member countries entitled 'Economic and Development Indicators and Statistics: Tuna Fisheries of the Western and Central Pacific Ocean'. Information in the 2022 edition of that report, incorporating available data up to and including 2021, has been used to provide much of the material summarised in this section.[159] In general, this information relates to the level of a particular activity rather than the economic benefits generated from the activity.

1.6.2.1 Tuna processing

An increasing proportion of the purse-seine catch from the waters of the nine tuna-dependent PICs is canned or loined in the region, together with the longline catch from a broader range of countries which is processed into fresh/frozen and value-added products mostly for sashimi and non-canned use. Most of the regional processing of the purse-seine catch is undertaken in PNG, Solomon Islands and Marshall Islands, whereas processing of longline catch occurs largely in Fiji.

Following a 20% increase in the annual volume of tuna processed (round weight) or handled onshore in the region in 2019, a further 19% increase in volume occurred in 2020, producing an estimated record volume of 266,000 tonnes (Table 1.11). In 2021, the volume processed or handled in the region accounted for 31% of catch taken by national fleets within the waters of participating countries, and 17% of the total catch from their EEZs. Around 48% of the tuna processed or handled onshore in the region is processed in PNG, with 18%, 17%, 12% and 4% processed in Marshall Islands, Fiji, Solomon Islands and other FFA member countries, respectively.

Table 0.11 Volume of tuna processed onshore in participating countries (note that data include all types of processing from canning and loining to onshore sorting and packing. Data are indicative due to the generally poor response to data requests from processors).

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Cook Islands	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.1	0.1
Fiji	9.3	8.7	14	34	35	35	35	59	57	34	49	43
FSM	0.7	0.2	0.1	1.9	2.8	2.8	4.0	6.0	4.9	28	55	36
Kiribati	-	-	0.0	0.2	0.2	0.4	0.4	0.4	0.4	2	1	1
Marshall Islands	7.2	9.5	5.4	12	14	10	9.8	7.2	8.3	15	15	10
Nauru	-	-	-	-	-	-	-	-	-	-	-	-
Niue	-	-	-	-	-	-	-	-	-	-	-	-
Palau	0.6	2.2	2.2	2.1	1.8	1.0	1.8	-	-	-	-	-
PNG	50	52	63	67	67	66	65	85	87	107	111	117
Samoa	4.3	1.9	2.7	2.2	1.3	1.3	5.7	7.3	5.1	6	6	2
Solomon Island	16	20	13	25	40	29	24	19	21	28	26	30
Tokelau	-	-	-	-	-	-	-	-	-	-	-	-
Tonga	0.1	0.2	0.1	0.1	0.3	0.4	1.9	1.6	0.9	2.9	2.2	2.5
Tuvalu	-	-	-	-	-	-	-	-	-	-	-	-
Vanuatu	0.3	0.6	0.7	0.2	0.2	-	-	-	-	0.1	1.0	3.7
Total	**88**	**95**	**102**	**144**	**163**	**146**	**148**	**186**	**185**	**223**	**266**	**245**

1.6.2.2 Unloadings

Unloading (transhipping) of catches from purse-seine vessels to fish carrier vessels ('Reefers') at ports in participating countries for transport to canneries in the region and elsewhere were on an upward trend after 2017 until 2020 and 2021, when they declined by 12% and 6%, respectively (Table 1.12). This was largely due to the Covid-19 border control measures imposed by FFA members, resulting in a number of ports being closed, and the extended vessel quarantine periods that exacerbated the situation for purse-seine operators offloading their catch in port. In 2020, the subsequent results were seen with reduced unloading volumes in FFA member countries caused in part by the pandemic and the decision of some countries to close their borders.

Table 0.12. Volume of tuna (tonnes) unloaded by purse-seine vessels in participating country ports between 2012 and 2021.

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Fiji	972	220	7,002	7,460	6,033	3,166	160	1,610		
FSM	170,158	256,052	120,697	65,891	146,590	175,147	285,545	165,227	182,461	152,218
Kiribati	180,677	135,119	289,525	250,640	128,389	147,732	213,449	496,868	311,793	324,366
Marshall Islands	320,594	282,171	498,911	391,364	397,736	294,218	296,910	353,382	133,042	206,280
New Zealand	2,185	2,260	4,484	1,282	211		930	1,348	265	
PNG	298,958	271,104	125,529	116,479	122,726	191,902	159,523	143,874	332,107	332,747
Samoa			219					6,187		
Solomon Islands	64,550	133,259	45,732	63,126	116,474	116,113	72,249	48,864	84,069	37,297
Tuvalu	27,943	3,770	33,492	140,106	116,026	150,118	176,542	125,857	139,039	58,202
Total	**1,066,036**	**1,083,954**	**1,125,590**	**1,036,348**	**1,034,185**	**1,078,395**	**1,205,309**	**1,343,217**	**1,182,774**	**1,111,109**

1.6.2.3 Employment

Total employment related to tuna fisheries in the participating countries was estimated to be 26,735 in 2021, an increase of 5% from 2020 and 38% since 2015 (Figure 1.15). This is attributed to an 8% increase in employment in the harvest sector and a 5% increase in both the processing and public sectors. Since 2010, there has been consistent growth in employment numbers, with the onshore processing sector making the largest contribution of about 60-70%, reaching 17,409 in 2021. The majority (73%) of employees in the processing sector in 2021 worked in PNG, with 13% in Solomon Islands and 10% in Fiji. Employment in the processing sector at the factory floor level is dominated by women, who make up 64% of the total processing workforce. Employment in the harvest and observer sector is dominated by men.

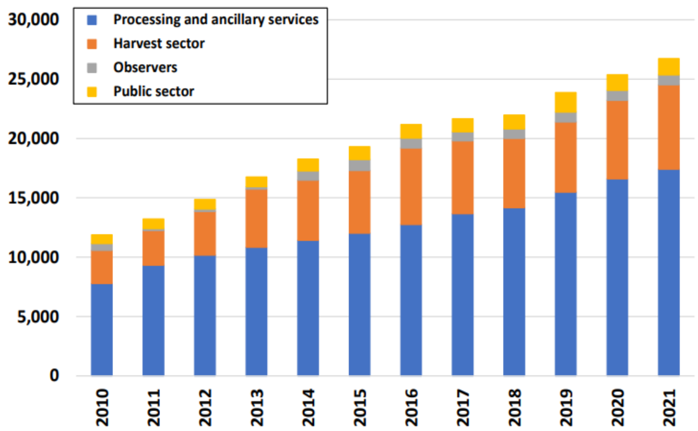

Figure 0.15 Tuna fisheries-related employment in participating countries between 2010 and 2021.

1.6.2.4 Exports

The value of tuna exports from participating countries is based on import data from the four major export destinations: Thailand, EU, USA and Japan (Figure 1.16). Following a steady increase between 2014 and 2018 export values stabilised, reaching $915 million in 2021.

Thailand, as the world's largest processor of tuna for canning, imported frozen material from the region valued at $469 million (c.i.f) in 2021, a 43% increase since 2016. This was also equivalent to 51% of the total value of all imports from the region.

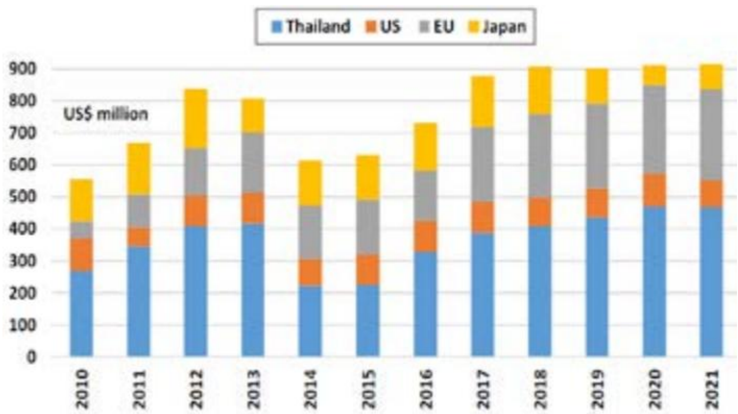

Figure 0.16 Imports of tuna from participating countries into major markets.

The trend across product types was mixed (Figure 1.17). Fresh exports, which have been declining over the last decade, collapsed in 2020, falling by nearly two thirds to just $17 million. This initially occurred as a result of supply chain disruptions caused by Covid-19 and associated border control measures. As a result, longline vessels reconfigured to supply frozen rather than fresh product. In response, exports of frozen products increased to $546 million. The value of loin exports was 36% higher in 2021 than in 2016. The prepared/preserved (typically canned) product also experienced an increasing trend in the last decade, with the value of exports reaching $127 million in 2021.

The increase in total value of imports from participating countries from 2020 to 2021 is attributed to an increase in the volume of imports from PNG fleets, which accounted for $227 million or 25% of the total value of imports from the region. In addition, recent expansion in fleets from FSM and Nauru transformed those flag States into important raw material suppliers to Thailand in 2021, with FSM contributing exports valued at $168 million (18%) and Nauru at $108 million (12%).

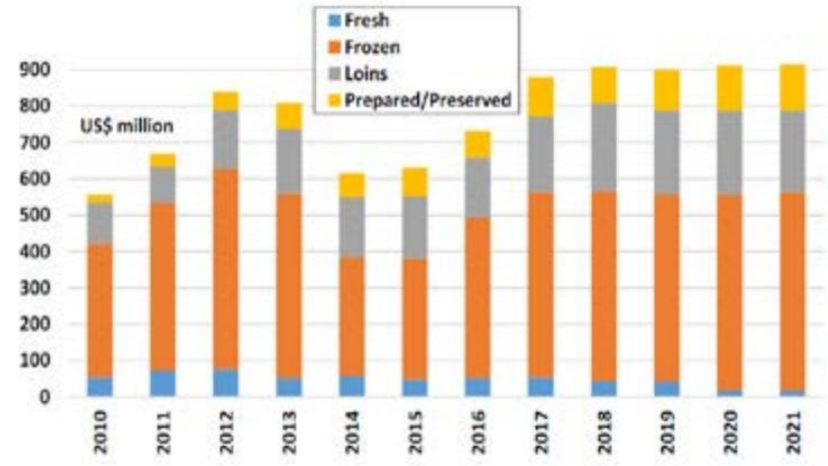

Figure 0.17. Imports of tuna from participating countries by major markets by product type.

1.6.2.5 Summary of economic benefits from domestic activities related to tuna fishing

The estimated economic benefits to participating countries generated by domestic industrial tuna-fishing operations within their EEZs and onshore processing activities over the period 2013 to 2019 are summarised in Table 1.13.

In 2019, the domestic harvest and processing sectors in the region:

- generated a net inflow of $687 million benefit to the balance of payments in the form of net exports;
- paid $72 million to national employees; and
- made net purchases of goods and services to local economies worth $147 million.

Table 0.13 Economic contributions from domestic harvest and processing sectors (USD millions).

Year	Balance of payments	Employment earnings	Net local purchases
2013	540	40	115
2014	576	55	130
2015	559	52	125
2016	544	57	121
2017	590	69	137
2018	656	71	149
2019	687	72	147

1.6.3 Contribution of tuna-fishing access fees to government revenue

In 2021, government revenue from access fees associated with industrial tuna fishing in the EEZs of countries participating in the RTP totalled $482 million, 3% lower than in 2018 when access fees peaked at $497 million (Figure 1.18). Access fee revenues received between 2017 and 2021 have generally stabilised following rapid growth during the previous decade.

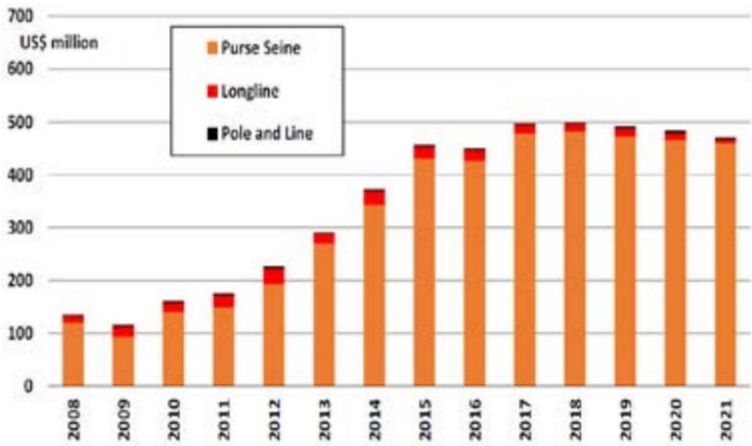

Figure 0.18. Tuna-fishing access fees paid to participating countries, by gear type, under fisheries access arrangements for vessels from distant water fishing nations and from other FFA member countries, for the period 2008-2021.

Over the 10 years prior to 2021, total access fee revenue more than doubled, at an average annual growth rate of 11%. This success has been driven by returns from the purse-seine fishery, with access fees from the longline fishery stagnant. The increase in revenue from purse-seine fleets has been achieved not through an increase in the catch value, but by an increase in the rate of return from foreign vessels through the PNA Vessel Day Scheme (see Section 1.4.2).

In 2013, purse-seine access revenue equated to less than 10% of the value of the catch taken in the combined EEZs of PNA members, whereas since 2015 the rate of return has been c.a. 20%. In contrast, the rate of return from foreign vessels in the longline fishery has remained at around 4-5% of the value of the catch. Sustained increases in access fee revenues from the longline fisheries will likely only be achieved by increasing the rate of return earned, which requires improvements in the management of the fishery and particularly better specification of zone-based limits for fishing within EEZs and the high seas.

A summary of tuna-fishing access fees earned by each participating country in 2021 is shown in Figure 1.19, and the percentage contribution of these fees to total (non-grant) government revenue for each country is provided in Table 1.14. Average access fees earnings by each of the nine tuna-dependent participating countries, and the average contribution of these fees to government revenue in each of these countries, over a 4-year period are shown in Figure 2.2 in Chapter 2.

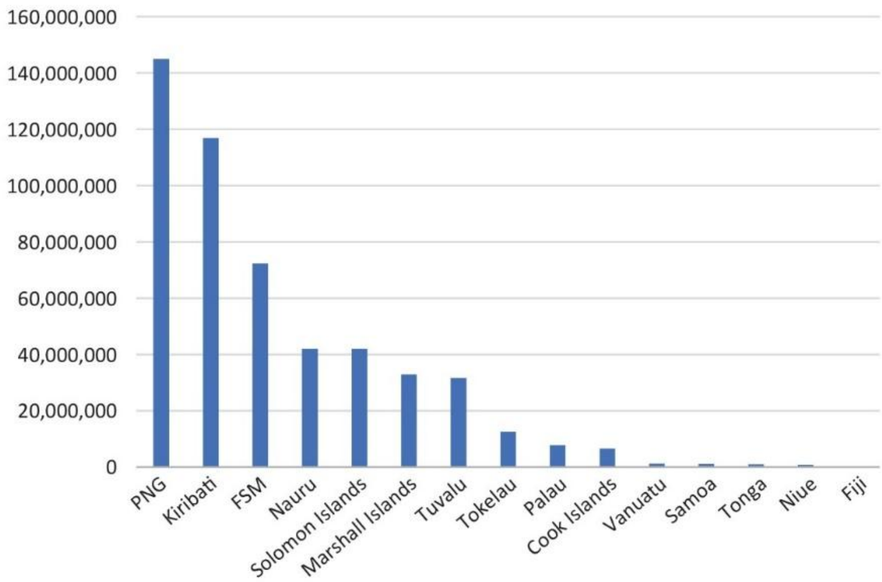

Figure 0.19. Tuna-fishing access fees paid to participating countries in 2021 (or the year for which the latest data are available).

Table 0.14 Tuna-fishing access fees paid to participating countries in 2021 (or the year for which the latest data are available).

	Access fees (US$)	**Access fees as % of government revenue**	**Other information**
Cook Islands	6,598,639	4.70%	For FY 2020/21
FSM	72,300,000	25.60%	For FY 2020; fees are an estimate by IMF
Fiji	163,174	0.01%	For FY 2018/19
Kiribati	116,989,340	65.50%	For 2021
Marshall Islands	33,031,253	18.90%	For FY 2021; this is the money received by MIMRA
Nauru	42,165,943	18.00%	For FY 2021/22
Niue	883,086	4.30%	For FY 2021/22
Palau	7,870,000	7.00%	Fees are for calendar year 2021; government revenue is for FY 2021
PNG	145,014,245	3.10%	For 2021
Samoa	1,119,691	0.37%	Fees are for calendar year 2021; government revenue is for FY 2021
Solomon Islands	42,110,205	8.90%	For 2020
Tonga	1,045,629	0.50%	For FY 2021/22
Tuvalu	31,650,914	76.30%	For 2021
Vanuatu	1,253,206	1.50%	For 2021

1.6.4 Contribution of fisheries to Gross Domestic Product

The latest available official estimates of GDP, and the contribution of fisheries to GDP, for each of the countries participating in the RFP is presented in Table 1.15.

A recent assessment of the contribution of the fisheries sector to GDP in the Pacific Islands region noted that, in some of the countries, the methods used to calculate the fisheries component of GDP were well documented, whereas in others there is a low level of confidence in official estimates.[160] The main reason for this is that the fisheries sector is poorly understood by those responsible for preparing GDP estimates, particularly in regard to the contribution of the informal subsistence and small-scale commercial sectors and inclusion, or exclusion, of the contribution of locally-based ('flagged') foreign fishing fleets.[161] As a consequence of the recent assessment, it has been proposed that the methodology for estimating GDP in Pacific Island countries requires substantive review.[162]

Table 0.15 Estimates of GDP, and contribution of fisheries to GDP, for each participating country.

Country	GDP (USD; '000s)	Fisheries GDP contribution (USD; '000s)	Fisheries as a % of GDP	Year and status of GDP estimate	Comments
Cook Is	315,170	1,361	0.4	2021	The sector is referred to as "Fishing (including pearls)"
FSM	227,700	17,600	7.7	FY 2018	GDP contribution excludes foreign-owned, locally-based fishing vessels; includes operations of DSG and CFC
Fiji	4,196,179	31,509	0.8	2021 provisional	The sector is referred to as "fishing and aquaculture"
Kiribati	219,415	17,530	8.0	2021 provisional	The fishing sector has 4 sub-sectors
Marshall Is	259,500	54,500	21.0	FY 2021	The GDP contribution excludes the locally based offshore fishing vessels
Nauru	134,783	2,681	2.0	FY 2020	
Niue	29,616	---	----	2018	The fishing contribution is aggregated with agriculture
Palau	217,800	4,300	2.0	2021 provisional	GDP contribution excludes locally-based offshore fishing vessels
PNG	23,504,274	360,114	1.5	2020	Fishing sector has 2 sub-sectors: formal and informal
Samoa	846,023	14,440	1.7	2021	Fishing sector has market & non-market components
Solomon Is	1,567,329	95,081	6.1	2020 provisional	Fishing sector comprised of formal and informal members, the latter made up of commercial and subsistence fishing
Tonga	468,799	10,272	2.2	2020/21 provisional	Fishing sector has market, non-market and export components
Tuvalu	56,477	1,933	3.4	2019	
Vanuatu	928,000	6,094	0.7	2020	Fisheries production is from the 2006 Agriculture Survey

1.7 National and regional fisheries policies and institutional arrangements

The importance of coastal fisheries resources for food security, and the region's rich tuna resources for economic development, is recognised at the highest political level in all 14 Pacific Island countries participating in the RTP. This section provides summaries of the numerous policies and institutional arrangements that have been developed across the region to sustain (and where possible further improve), the valuable contributions that these fisheries resources make to the nutrition of communities and development of national economies.

1.7.1 Coastal fisheries

1.7.1.1 Regional arrangements supporting sustainable management of coastal fisheries

The management of coastal fisheries differs considerably from the frameworks developed by FFA and PNA to manage the region's shared tuna resources (see Section 1.7.2.1 below). This is because the coastal fisheries resources within the waters of each country are generally regarded as being separate biological populations (stocks). Consequently, coastal fisheries are managed nationally, not through multi-national collaboration. There is the possibility that genetic connectivity occurs between countries in close proximity (e.g., PNG and Solomon Islands) for coastal fisheries species with extended pelagic larval stages (e.g., surgeonfish, spiny lobsters) but this has yet to be determined.

Regional cooperation in relation to coastal fisheries does occur on one level, however. The participating countries regularly share information and lessons learned from experience at the national level that might be adapted for application in fishery development and management situations in neighbouring countries. In particular, community-based resource management (CBRM) approaches are receiving increasing attention in contemporary strategies for the management and conservation of inshore fisheries resources in PICs. CBRM is actively promoted by non-governmental organisations (NGOs) across the region, largely because of the predominance of traditional management systems, poor formal fisheries governance structures for coastal fisheries management and under-resourced central agencies.

The CBRM model focusses on strengthening the capacity, and responsibilities, of local communities, supported through governance reforms being undertaken by governments, to regulate and manage resource use utilising local institutions, such as Local Government Councils or village institutions. The premise is that these institutions are more effective when the resource users themselves are actively engaged in decision-making regarding local resource use.

Regional engagement, facilitation, and coordination in coastal fisheries (and aquaculture) is the responsibility of the SPC through its Coastal Fisheries and Aquaculture Programme (CFAP) within the Fisheries, Aquaculture and Marine Ecosystems (FAME) Division.

The CFAP provides science and technical support to SPC's Members to enhance the management of coastal fisheries, and the sustainable development of aquaculture and nearshore livelihoods, as well as the production and dissemination of relevant information. CFAP's work programme is developed annually based on the FAME Business Plan. Notably, the work of CFAP also includes activities related to assisting coastal communities to benefit from the tuna resources described in Section 1.4.2 occurring in nearshore waters. The CFAP's work in this regard has primarily been concerned with the provision of technical advice and assistance for the deployment and management of nearshore anchored FADs, sea safety and small-scale vessel design.

CFAP collaborates with a range of partners across the region, including other regional and international organizations, NGOs, research or management institutions, the private sector, communities and other stakeholders in marine activities. Cross-cutting issues, such as food security and climate change are being addressed through a holistic approach where CFAP is a partner with other sections and programmes within SPC, as well as with external partners.

The SPC convenes a Heads of Fisheries (HoF) Meeting for its 27 island and metropolitan Members annually. The HoF is the only regional forum for discussion and priority-setting for coastal fisheries and aquaculture, and for the joint consideration of oceanic and coastal fisheries, where all SPC Members participate. HoF reports to SPC's governing body, the Committee of Representatives of Governments and Administrations (CRGA). In collaboration with FFA and other regional agencies that participate in the Council of Regional Organisations of the Pacific (CROP), SPC also provides strategic and policy support to the Regional Fisheries Minister's Meeting (RFMM, see below).

In early 2015, SPC Members, working in close collaboration with a strong civil society representation at the 9th HoF Meeting, produced the *New Song for Coastal Fisheries*[163] which was subsequently taken up nationally and regionally as the key strategic document for management of coastal fisheries in the region.

In late 2015, at the 46th meeting of the Pacific Islands Forum (PIF), Leaders endorsed the *Future of Fisheries: A Regional Roadmap for Sustainable Pacific Fisheries,* which supports strategic interventions in both coastal and tuna fisheries through to 2025. Preparatory arrangements are currently underway to review the *Regional Roadmap*.

In 2016, the Pacific Island Leaders noted:

> "……. That coastal fisheries management continues to receive inadequate attention at the national level, Leaders agreed to expand the broad heading of "fisheries" to include coastal fisheries, noting links to communities, food security, health issues and in particular non-communicable diseases. Leaders also noted the need to ensure ecosystem integrity to address issues such as ciguatera fish poisoning outbreaks and to sustainably manage bêche-de-mer. To that end, Leaders tasked the SPC to coordinate with National Fisheries Agencies, CROP agencies and regional and national community groups, to strengthen support and resourcing for coastal fisheries management." (47th Pacific Islands Forum Communique).

In September 2017, at their meeting in Samoa, Leaders reconfirmed fisheries as a standing agenda item:

> "41. Leaders endorsed fisheries and climate change to be standing agenda items for Forum Leaders given that they are both key regional priorities that require a whole-of-government approach, foremost Leaders' close oversight." (48th Pacific Islands Forum Communiqué[164]).

In recognition of the increasing regional attention to fisheries matters, following a decision by Forum Leaders in 2018 to request more comprehensive updates on the fisheries work of Pacific regional organisations (FFA, SPC, SPREP, PIFS[165] and the PNA), in 2020 a Regional Fisheries Ministers Meeting (RFMM) was launched.[166] The RFMM report to Forum Leaders under a Standing Agenda Item on Fisheries includes progress with implementation of the *Regional Roadmap* and provides advice and recommendations on both coastal and oceanic fisheries issues requiring Leaders' attention. The separate Forum Fisheries Committee Ministerial (FFCMIN) meeting for FFA member countries, which focuses on oceanic fisheries and is arranged by the FFA, also reports directly to Forum Leaders.

The HoF is supported by a Regional Technical Meeting on Coastal Fisheries (RTMCF) which met for the first time in November 2017. It has since met on five occasions. The agenda of the RTMCF includes an item that is reserved for community-based coastal fisheries (called a Dialogue). The Dialogue is facilitated by a representative from civil society, with the report of the Dialogue being included in the Report of the RMTCF to HoF.

In addition, the Marine Sector Working Group (MSG) (see below) developed a *Roadmap for inshore fisheries management and sustainable development 2015-2024*.

The *New Song* and the *Regional Roadmap* collectively call on Pacific Island countries and territories to implement integrated coastal resource management arrangements, drawing on the strengths and traditions of community, district, provincial and national levels of government to achieve sustainable island life. Coastal fisheries are complex and interdependent social and ecological systems that are influenced by many factors, such as national governance, trade and land-based activities. Their management, therefore, faces many challenges in balancing development aspirations and sustainability, and in adapting to change, such as that caused by climate, outside the influence of coastal communities.

1.7.1.2 National arrangements supporting management of coastal fisheries

Each of the participating countries has a national fisheries agencies dedicated to managing coastal fisheries sustainably, supported by the regional initiatives described above. In case of several of these countries, particularly in Melanesia, approaches to managing coastal fisheries resources recognise *Customary Marine Tenure*, whereby local communities have historically determined the scope of activities in nearshore areas within their customary influence. The drivers for decision-making in relation to these nearshore areas have generally been associated with securing livelihoods but also include cultural, spiritual, aesthetic and security-related considerations.[167]

Customary management arrangements have been strengthened in some places in spite of increasing commercialisation, and their use for long-term management and conservation of coastal fisheries resources continues to generate interest among fisheries policy makers, researchers and planners. These arrangements are generally locally acceptable, 'self-policing' and support decentralised decision making. They are in contrast with the high costs and often more complex centrally-imposed management regulations needed for multi-species, widely dispersed, fisheries that support a large number of small, opportunistic fishing activities and landing sites.[168] Community-based fisheries management (CBFM[169]), or co-management, which combine some of the methods of contemporary fisheries managers with the knowledge and skills of local resource-users operating under customary marine tenure has broad support across communities and civil society in the region.[170] CBFM approaches may include species-specific reserves, temporary fishing reserves or closures and harvest limitations.[171]

1.7.2 Industrial tuna fisheries

1.7.2.1 Regional arrangements supporting sustainable management of tuna fisheries

Three organisations have pivotal roles in development of technical advice and coordination of policies to support decision-making relating to the sustainable management of the region's tuna resources: SPC, FFA and PNA. These three regional/sub-regional agencies are partners in the RTP at various levels. Summaries of their mandates and operations are provided below. The WCPFC is also an important stakeholder in the region's tuna fisheries. It is responsible for the conservation and management of tuna on the high seas throughout the WCPO. The membership of WCPFC includes all 14 participating countries. The provisions of the Convention establishing WCPFC provides for compatibility between the conservation and management arrangements that are adopted at the Commission and those that coastal States implement within areas under national jurisdiction. Consequently, although not a formal partner in the RTP, the WCPFC is intimately associated with Programme activities and the outcomes of Programme-related initiatives are expected to influence decisions at the Commission.

There are numerous other regional and sub-regional organisations and arrangements with activities covering tuna fisheries that Pacific Island countries participate in. The mandates and services provided by these agencies and arrangements are summarised in **Appendix 1-G**.

Pacific Community (SPC)

Since its establishment in 1947, SPC has provided scientific and technical development support to its 27 country and territory members.[172] SPC's vision for the region is a secure and prosperous Pacific Community whose people are educated and healthy and manage their resources in a sustainable way. The organization's priorities are elaborated in its 2022-2031 Strategic Plan.

SPC's governing body is the Conference of the Pacific Community, which is charged with establishing the high-level, strategic orientations of the organisation. It meets every two years at the ministerial level. In years when the Conference does not meet, the CRGA is empowered to make decisions on governance issues. SPC provides services through its eight divisions:

- Climate Change and Environmental Sustainability.
- Educational Quality and Assessment.
- Fisheries, Aquaculture and Marine Ecosystems.
- Geoscience, Energy and Maritime.
- Human Rights and Social Development.
- Land Resources.
- Public Health.
- Statistics for Development.

The purpose of the FAME Division is to provide the 22 Pacific Island countries and territories Members of SPC with the information they need to make informed decisions on the management and development of their aquatic resources and help to provide the tools and strengthen the capacity needed to implement these decisions.

The Oceanic Fisheries Programme (OFP) within FAME is the Pacific Community's regional centre for tuna fisheries research, fishery monitoring, stock assessment and data management. It was established by the 1980 South Pacific Conference (as the Tuna and Billfish Assessment Programme) to continue and expand the work initiated by its predecessor, the Skipjack Survey and Assessment Programme. The OFP has been the science services and data management provider to the WCPFC since the establishment of the Commission.

The OFP also provides technical assistance, training, scientific support and data management services to other subregional and regional organizations particularly FFA and PNA. The OFP's main activities in related to fisheries are training, support for oceanic fishery monitoring (observers and port samplers), fisheries catch and effort data management, scientific information on biology and ecology of tuna and large pelagic fish species, ecosystem modelling, information on impacts of climate change, stock assessments of tuna, billfish and key shark species, and the provision of scientific advice to inform management decisions.

The OFP collaborates with a number of established academic and scientific institutions on a range of oceanic and fisheries initiatives related to its work on the oceanography of the WCPO and biology, trophic and ecological relationships, stock structure and dynamics and fishery assessments for Pacific Island countries. Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) has been a long-term collaborator in this regard and will partner with SPC on a range of activities associated with the RTP (see **Chapter 4**).

Pacific Islands Forum Fisheries Agency (FFA)

The FFA is a multilateral organization composed of 15 Pacific Island countries and territories as Members (plus Australia and New Zealand). The purpose of the FFA is to strengthen the national capacity of its Members and regional cooperation for the sustainable management and development of their offshore fisheries resources. The FFA is not a regulatory body, but Members regularly develop joint policy and administrative positions on a broad range of fisheries issues. FFA Members' cooperation on their shared interests and joint policy positions often results in the submission of proposals to WCPFC and, with their 17-member voting bloc, they have a strong influence on the decisions of the Commission.

The FFA Secretariat provides advice on options for fisheries development and economic assessments, including facilitating investment in onshore facilities such as fish processing plants (canneries). FFA also facilitates bilateral and multilateral negotiations between its Members and foreign fleets, and supports a diverse programme focused on Monitoring, Control and Surveillance (MCS).

Cooperative mechanisms implemented by FFA Members include the FFA Vessel Register, the FFA vessel monitoring system (VMS) and the Regional Surveillance Program. They have also agreed, and regularly update, the *Harmonised Minimum Terms and Conditions for Access by Fishing Vessels* (HMTCs), which contain a detailed set of conditions related to foreign fishing vessel access to their EEZs and include MCS, labour and employment provisions. These are implemented by each FFA member through their national legislation, access agreements and vessel licence conditions. The HMTCs include conditions requiring foreign fishing vessels to be placed on the FFA Vessel Register prior to being considered for licensing, transhipment obligations, data reporting, and participation in the centrally-administered VMS.

Parties to the Nauru Agreement (PNA)

Collaboration among FFA countries has also led to the development of a range of arrangements between sub-regional and smaller groups comprised of FFA Members to cater for their bespoke needs and opportunities.

The most prominent of the groups within FFA is the PNA, comprised of Federated States of Micronesia, Kiribati, Marshall Islands, Nauru, Palau, Papua New Guinea, Solomon Islands and Tuvalu. The EEZs of PNA Members produce around 50% of the tropical tuna caught in the WCPO and 30% of the world's skipjack tuna. PNA countries work together to cooperatively manage tuna fisheries within their combined EEZs, with the primary tools being the purse-seine and longline Vessel Day Schemes (VDS). The later was developed, and now operates, under the 1995 Palau Arrangement for the Management of Western Pacific Purse-Seine Fisheries.

The purse-seine VDS limits fishing effort across the PNA EEZs through an agreed Total Allowable Effort (TAE), which is then distributed among PNA Members as Party Allowable Effort (PAE). A benchmark fee is agreed, and each country then allocates their PAE among fleets and vessels through mechanisms of their choice (e.g., auction, tender, bilateral agreement, domestic vessel priority), in accordance with basic rules agreed among all Members. The VDS allows trading of days between Members and the pooling of days, where purchasers of the pooled days can use them anywhere in the participating countries' EEZs.[173]

The PNA's Longline Vessel Day Scheme (LL VDS), introduced in 2017, establishes a TAE for longline effort in all Parties' waters, within which it has allocated longline PAEs. The PNA LL-VDS covers all tuna longline fisheries in the EEZs of all PNA Members plus Tokelau and accounts for significant catches of South Pacific albacore. Similar to the purse-seine VDS, vessels participating in the longline VDS are required to pay for each fishing day, and trading between countries is supported. In contrast to the substantive demand for purse-seine VDS days, the longline VDS has not yet been fully subscribed and days are sold at a flat price set by each country.

Another sub-group of FFA members, the Te Vaka Moana[174] (TVM, see below), has also been engaged in discussions to coordinate management arrangements for the longline fishery for albacore in their EEZs. However, no specific management measures have been agreed at this time.

In addition to limiting fishing days, the PNA has agreed to a common set of supplementary requirements, in the form of Implementing Arrangements, for purse-seine and longline vessels fishing within their EEZs. These include restrictions on use of drifting Fish Aggregating Devices (FADs) deployed by purse-seine vessels, transhipment of tuna catches at sea, fishing in high seas pockets and requirements for reporting and observers. Although most of these requirements are consistent with WCPFC's Conservation and Management Measures (see below) and other regulatory decisions, others exceed WCPFC obligations.

Examples of management measures taken by the PNA, and subsequently incorporated into WCPFC CMMs, include bans on FAD sets by purse-seine vessels during specific months of the year, and full tuna catch retention. The PNA has also led work on developing target reference points and management procedures for the harvest strategies for WCPO target tuna stocks with an initial focus on skipjack tuna.

Two sub-regional arrangements have been implemented for the administration of purse-seine vessels that operate in the WCPO – the US Tuna Treaty, which provides for access of up to 40 US-flagged purse-seiners to FFA EEZs and the adjacent high seas, and the FSM arrangement, which provides for access of vessels flagged (or otherwise sponsored) by PNA Members to each other's EEZs. These two arrangements deal primarily with licensing and, while they provide for certain data collection obligations, are primarily administrative rather than management arrangements.

Both FFA and the PNA support a governing council convened at an official's level – respectively, the Forum Fisheries Committee (FFC) and PNA Officials' meetings. The meetings of officials subsequently report to a ministerial meeting (see below).

Western and Central Pacific Fisheries Commission (WCPFC)

Since entering into force in 2004, acting on the advice of its subsidiary bodies,[175] the WCPFC has adopted numerous Conservation and Management Measures (CMMs). The primary CMM that regulates the management of fisheries for tropical tuna species (skipjack, bigeye and yellowfin) is CMM 2021-01 and its predecessors. CMM 2021-01 describes permitted activities in the purse-seine and longline fisheries through provisions such as catch and effort limits, retention of catch requirements, and seasonal closures in relation to fishing with FADs. In relation to climate change, the pre-ambular provisions of CMM 2021-01 include:

> Recognizing the United Nations' Climate Change Sustainable Development Goal to "take urgent action to combat climate change and its impacts", and that climate change has particularly negative impacts on Small Island Developing States and Territories; and noting that Article 5 (c) of the Convention requires the application of the precautionary approach, and Article 5 (d) of the Convention requires the Commission to assess the impacts of fishing, other human activities and environmental factors on target stocks, non-target species, and species belonging to the same ecosystem or depend upon or associated with the target stocks;
>
> Noting the SEAPODYM[176] analyses presented to the 11th Regular Session of the WCPFC Scientific Committee (SC11), SC12 and SC13 on the projected impacts of climate change will have on tuna distribution, larval numbers and stock biomass, the WCPFC needs to build resilience into the medium and long-term planning and manage WCPO fish stocks in a precautionary manner, and Article 30(2)(c) of the Convention requires the Commission to ensure there is no disproportionate burden of conservation action on developing States, Parties and Territories.

In addition, in 2019, the Commission agreed to a voluntary Resolution focussed on considerations relating to climate change and its impacts on the management and conservation of WCPO tuna stocks. Resolution 2019-01 provides that the Commission will, *inter alia,*

> Take into account in its deliberations, including in the development of conservation and management measures, scientific information available from the Scientific Committee on the potential impacts of climate change on target stocks, non-target species, and species belonging to the same ecosystem or dependent on or associated with the target stocks,

At its meeting in 2022, the Commission adopted a recommendation from its Scientific Committee (SC) that ecosystem and climate indicators be established as a standing agenda item under the SC's theme on ecosystem and bycatch mitigation. The SC had developed a mechanism to track progress in this endeavour by adopting appropriate indicators.[177] Further, a proposal submitted by the USA, co-sponsored by FFA Members, to establish climate change as a standing agenda item for the Commission and all of its subsidiary bodies, was adopted.[178]

There are also a range of other CMMs which are often specific to fishing gear types that are used to target different species. These include CMMs that provide, *inter alia*, for data reporting obligations, limits the number of vessels fishing for South Pacific albacore south of 20°S, the management of interactions with species taken incidentally and protected species, including swordfish, striped marlin, sharks, sea turtles, sea birds and cetaceans. Several CMMs have also been agreed that specify MCS requirements, such as vessel registration, reporting, boarding and inspection, observers, VMS, transhipment, port State measures and a Compliance Monitoring Scheme.

1.7.2.2 National arrangements supporting sustainable management of tuna fisheries

Most of the Pacific Island Members of the FFA have national Tuna Management Plans (TMPs) that provide guidelines for catch and/or effort levels for the various fisheries operating in their EEZs. These plans usually articulate aspirations for domestic tuna fisheries development and, through a process coordinated by FFA, and assisted by SPC at a technical level, incorporate an ecosystem approach to fisheries management.

Some national TMPs provide for limits on EEZ-based catch and/or effort, but most do not because national catch and/or effort limits need to be coordinated among coastal States so that the sum of such limits is consistent with stock-wide sustainable exploitation.

WCPFC's CMMs and subregional decisions are implemented in national fisheries legislation within EEZs and by the nations with vessels fishing on the high seas. Individual countries do not rely on decisions taken within the Commission, or other groups, to drive national management and they make decisions for their own EEZs. An example is the Palau 'shark haven', declared in 2009, which banned commercial fishing for sharks within the nation's EEZ.

Appendices

Appendix 1-A Participating country profiles

Appendix 1-B Ecological provinces of the Pacific Ocean and their influence of tuna food webs

Appendix 1-C Fish caught for domestic consumption, exported invertebrates, and fishing methods

Appendix 1-D Target tuna species in WCPO commercial tuna fisheries

Appendix 1-E Summary of the catch of tuna from WCPO tuna fisheries by gear type

Appendix 1-F Contribution of coastal fisheries production, and canned fish, to local diets

Appendix 1-G Supplementary summary of regional and sub-regional arrangements

Endnotes

[1] Summerhayes, G.R., Matisoo-Smith, E., Mandui, H., Allen, J., Specht, J., Hogg, N. and McPherson, S. 2010. Tamuarawai (EQS): An Early Lapita Site on Emirau, New Ireland, PNG. *Journal of Pacific Archaeology.* Vol. 1,· No. 1. Pages 62-76.

[2] Leavesley, M.G., Bird, M.I., Hausladen, P.A., Santos, G.M. and di Tada, M.L. 2002. Buang Merabak: Early evidence for human occupation In the Bismarck Archipelago, Papua New Guinea. *Australian Archaeology*. Volume 54, Issue 1:51-57.

[3] Kirch, P.V. 2017. On the Road of the Winds: An Archaeological History of the Pacific Islands before European Contact. Revised and Expanded Edition. University of California Press. 408 pages; Shepherd, B., Serafica, R.B., Bayhaqi, A and Jing, H. 2011. The Trade Impact of Enhanced Multimodal Connectivity in the Asia-Pacific Region. Journal of Economic Integration Vol. 26, no. 4. pp. 624-650. Sejong University; Petchey, F., Spriggs, M., Bedford, S., Valentin, F., and Buckley, H. 2014. Radiocarbon dating of burials from the Teouma Lapita cemetery, Efate, Vanuatu. ScienceDirect Vol. 50 (October 2014), pp.227-242. https://www.sciencedirect.com/journal/journal-of-archaeological-science".; Summerhayes, G.R., Bird, J.R., Fullagar, R., Gosden, C., Specht, J. and Torrence, R. 1998. Application of PIXE-PIGME to Archaeological Analysis of Changing Patterns of Obsidian Use in West New Britain, Papua New Guinea. In: Shackley, M.S. (Eds) Archaeological Obsidian Studies. Advances in Archaeological and Museum Science, Vol 3. Springer, Boston, MA. https://doi.org/10.1007/978-1-4757-9276-8_6.

[4] Wollstein, A., Lao, O., Becker, C., Brauer, S., Trent, R.J., Nurnberg, P., Stoneking, M. and Kayser, M. Demographic History of Oceania Inferred from Genome-wide Data. *Current Biology*. Vol. 20, Issue 22. November 2010, pp. 1983-1992; Pugach, I., Duggan, A.T., Merriwether, A.T., Friedlaender, F.R., Friedlaender, J.S. and Stoneking, M. 2018. The Gateway from Near into Remote Oceania: New Insights from Genome-Wide Data, *Molecular Biology and Evolution*, Volume 35, Issue 4, April 2018. pp. 871–886. https://doi.org/10.1093/molbev/msx333; Spriggs, M. and Reich, D. 2020. An ancient DNA Pacific journey: a case study of collaboration between archaeologists and geneticists. *World Archaeology.* Vol. 51. 2019. Issue 4. Ancient DNA Research: Blessing or curse for archaeology? Pp. 620-639.

[5] Bell, J.D., Adams, T.J.H, Johnson, J.E., Hobday, A.J. and Sen Gupta, A. 2011. Pacific communities, fisheries, aquaculture and climate change: An introductionIn: Bell J.D., Johnson, J.E. and Hobday, A.J. 2011. *Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change*. Pages 1-47. Secretariat of the Pacific Community, Noumea, New Caledonia. 941 pages.

[6] This map is indicative only of agreed and potential maritime boundaries between Pacific Island countries and territories (PICTs). It does not reflect the claims of PICTs to offshore areas.

[7] Data sources: Phil Bright (*pers. comm.*) SPC's Statistics for Development Division and website - https://sdd.spc.int/ - population, land areas, population 1 and 5km from coast. EEZ areas drawn from SPC's Geoscience Maritime Boundaries dashboard (https://pacificdata.org/dashboard/maritime-boundaries). Coastline length was sourced from website: https://www.citypopulation.de/en/world/bymap/coastlines/. Also Figure 1 of the CI-SPC GCF RTP Concept Note.

[8] Andrews, N.L., Bright, P., de la Rua, L., Teoh, S.J. and Vickers, M. 2019. Coastal proximity of populations in 22 Pacific Island countries and territories. PLoS ONE 14(9): e0223249. https://doi.org/10.1371/journal.pone.0223249

[9] In addition to the 14 countries participating in the GCF Funding Proposal, the Pacific Islands region includes three Pacific territories of France (French Polynesia, New Caledonia and Wallis and Futuna), one unincorporated territory of the US (Guam) and two US territories (American Samoa and Commonwealth of Northern Marianas), the British Overseas Territory of Pitcairn and Tokelau, a non-self-governing territory of New Zealand. All 22 Pacific Island Countries and Territories (PICTs) are members of the Pacific Community (SPC).

[10] Firth, S. 2018. *Instability in the Pacific Islands: A status report*. © Lowy Institute for International Policy. http://hdl.handle.net/11540/8550.

[11] https://www.c-r.org/programme/pacific/bougainville-conflict-focus

[12] Doan, D., Poole, S., Haroutonian, A. and McDonald, A.2023. Final report: *Landscape and opportunity analysis in the Pacific tuna sector: Foundation analysis to identify innovation pathways to enhance participation by the Pacific community and value retention in the region*. AGB/2021/173, ACIAR, Canberra, Australia. 104 pages. Accessed 1 November 2023.

[13] Based on material in: Dalzell, P., Adams, T.J.H. and Polunin, N.V.C. 1996. Coastal fisheries in the Pacific Islands. *Oceanography and Marine Biology: An Annual Review*. 34, 395-531. © A. D. Ansell, R. N. Gibson and Margaret Barnes, Editors. UCL Press; Adams T.J.H., Friedman K., Kronen M., Pinca S., Ponia B. and Chapman L. 2008. Status report: Nearshore and reef fisheries and aquaculture. Noumea, New Caledonia: Secretariat of the Pacific Community. 37 pages. https://purl.org/spc/digilib/ doc/66mrt.

[14] Waycott, M., McKenzie, L.J., Mellors, J.E., Ellison, J.C., Sheaves, M.T., Collier, C., Schwarz, A-M., Webb, A., Johnson, J.E. and Payri, C.E. 2011. Vulnerability of mangroves, seagrasses and intertidal flats in the tropical Pacific to climate change. In: Bell J.D., Johnson, J.E. and Hobday, A.J. 2011. *Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change*. Pages 297-358. Secretariat of the Pacific Community, Noumea, New Caledonia. 941 pages.

[15] Hoegh-Guldberg, O., Andréfouët, S., Fabricius, K.E., Diaz-Pulido, G., Lough, J.M., Marshall, P.A., Morgan, S. and Pratchett, M.S. 2011. Vulnerability of coral reefs in the tropical Pacific to climate change. In: Bell J.D., Johnson, J.E. and Hobday, A.J. 2011. *Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change*. Pages 251-296. Secretariat of the Pacific Community, Noumea, New Caledonia. 941 pages.

[16] Jenkins, M., Sheppard, C. and Wells, S. 1988. *Coral reefs of the world. Vol. 3: Central and Western Pacific*, IUCN: International Union for Conservation of Nature. Exxon Corporation, IUCN Conservation Monitoring Centre, UNEP, United Nations Environment Stamp Conservation Fund, WWF. Retrieved from https://policycommons.net/artifacts/1371513/coral-reefs-of-the-world-vol-3/1985684/ on 25 Apr 2023. CID: 20.500.12592/zwjwzt.

[17] Veron, J.E.N. 1986. *Corals of Australia and the Indo-Pacific*. Angus and Robertson Publishers, North Ryde, Australia. 644 pages.

[18] Maragos, J.E and Williams, G.J. 2011. Pacific coral reefs: An introduction. Pages 753-825. In: David Hopley (Ed.), *Encyclopaedia of Modern Coral Reefs: Structure, form and process. 1,236 pages.* DOI 10.1007/978-90-481-2639-2, # Springer Science+Business Media B.V. 2011.

[19] Bell J.D., Johnson, J.E. and Hobday, A.J. 2011. *Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change*. Pages 251-296. Secretariat of the Pacific Community, Noumea, New Caledonia. 941 pages.

[20] Bell J.D. et al. 2009. Planning the use of fish for food security in the Pacific. Marine Policy 33: 64-76.

[21] Shearman, P.L., 2010. Recent change in the extent of mangroves in the northern Gulf of Papua, Papua New Guinea. *Ambio*, *39*:181-189.

[22] Ellison, J.C. 2009. Wetlands of the Pacific Island region. *Wetlands Ecology and Management.* Vol. 17, 169–206 (2009). https://doi.org/10.1007/s11273-008-9097-3

[23] Woodroffe C.D. 1987. Pacific island mangroves: distribution and environmental settings. Pac Sci 41: 166-185.

[24] Hatcher, B., Johannes, R. and Robinson, A., 1989. Review of the research relevant to the conservation of shallow tropical marine ecosystems. *Oceanography and Marine Biology*, *27*, pp.337-414.

[25] Based on material in: Dalzell, P., Adams, T.J.H. and Polunin, N.V.C. 1996. Coastal fisheries in the Pacific Islands. *Oceanography and Marine Biology: An Annual Review*. 34, 395-531. © A. D. Ansell, R. N. Gibson and Margaret Barnes, Editors. UCL Press; Adams T.J.H., Friedman K., Kronen M., Pinca S., Ponia B. and Chapman L. 2008. Status report: Nearshore and reef fisheries and aquaculture. Noumea, New Caledonia: Secretariat of the Pacific Community. 37 pages. https://purl.org/spc/digilib/ doc/66mrt.

[26] Waycott, M., McKenzie, L.J., Mellors, J.E., Ellison, J.C., Sheaves, M.T., Collier, C., Schwarz, A-M., Webb, A., Johnson, J.E. and Payri, C.E. 2011. Vulnerability of mangroves, seagrasses and intertidal flats in the tropical Pacific to climate change. In: Bell J.D., Johnson, J.E. and Hobday, A.J. 2011. *Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change*. Pages 297-358. Secretariat of the Pacific Community, Noumea, New Caledonia. 941 pages.

[27] Coles, R., Short, F., Fortes, M. and Kuo, J., 2014. Twenty years of seagrass networking and advancing seagrass science: The International Seagrass Biology Workshop Series. *Pacific Conservation Biology*, *20*(1), pp.8-16. Zann, L.P. 1994. The status of coral reefs in Southwestern Pacific Islands. *Marine Pollution Bulletin* Vol 29 Issue 1, pages 52-61; Wells, S.M. and Jenkins, M.D. 1988. Coral Reefs of the World. Vol. 3: Central and Western Pacific. UNEP, IUCN, Gland, Switzerland and Cambridge, UK (1988), 329 pages.

[28] SPC. 2024. Assessment of the vulnerability of Pacific Island communities and economies to the effects of climate change on fisheries. Prepared in support of a Funding Proposal to the Green Climate Fund, *Adapting tuna-dependent Pacific Island communities and economies to climate change*. Secretariat of the Pacific Community, Noumea, New Caledonia. Technical Study 1. 121 pages + appendices. https://fame1.spc.int/documents-in-support-funding-proposal-green-climate-fund-regional-tuna-programme

[29] After Longhurst, A.R. 2006. *Ecological geography of the sea*. 2nd Edition. 577 pages.

[30] After Longhurst, A.R. 2006. *Ecological geography of the sea*. 2nd Edition. 577 pages.

[31] Le Borgne R., Barber, R.T., Delcroix, T., Inoue, H.Y. and others. 2002. Pacific warm pool and divergence: Temporal and zonal variations on the equator and their effects on the biological pump. *Deep-Sea Research* II 49, 2471–2512.

[32] Le Borgne, R., Allain, V., Griffiths, S.P., Matear, R.J. McKinnon, A.D., Richardson, A.J. and Young, J.W. 2011. Vulnerability of open ocean food webs in the tropical Pacific to climate change. In: Bell J.D., Johnson, J.E. and Hobday, A.J. 2011. *Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change*. Pages 297-358. Secretariat of the Pacific Community, Noumea, New Caledonia. 941 pages.

[33] Maragos, J.E and Williams, G.J. 2011. Pacific coral reefs: An introduction. Pages 753-825. In: David Hopley (Ed.), *Encyclopaedia of Modern Coral Reefs: Structure, form and process. 1,236 pages.* DOI 10.1007/978-90-481-2639-2, # Springer Science+Business Media B.V. 2011.

[34] McIntyre, M. 2005. *Pacific Environment Outlook*. UNEP/SPREP. United Nations Environment Programme and the Secretariat of the Pacific Regional Environment Programme. 99 pages.

[35] UNEP/WCMC 2001. Cartographer Philippe Rekacewicz, UNEP/GRID-Arendal. http://maps.grida.no/go/graphic/distribution_of_coral_mangrove_and_seagrass_diversity

[36] Kulbicki, M., 1992. Present knowledge of the structure of coral reef fish assemblages in the Pacific. *Coastal resources and systems of the Pacific Basin: Investigation and steps toward protective management. UNEP Regional Seas Report and Studies*, *147*, pp.31-54.

[37] Hatcher, B., Johannes, R. and Robinson, A., 1989. Review of the research relevant to the conservation of shallow tropical marine ecosystems. *Oceanography and Marine Biology*, *27*, pp.337-414.

[38] Pyle, R.L., Kosaki, R.K., Pinheiro, H.T., Rocha, L.A., Whitton, R.K. and Copus, J.M. 2019. Fishes: biodiversity. *Mesophotic coral ecosystems*, pp.749-777.

[39] Adams, T. and Dalzell, P.J. 1995. Management of Pacific Island inshore fisheries. 3rd Australasian Fisheries Managers Conference, 2-4 August 1995, Rottnest Island, Western Australia. Integrated Coastal Fisheries Management Project, South Pacific Commission, BP D5, 98848 Nouméa Cedex, New Caledonia. 8 pages.

[40] Cernohorsky, W.O., 1978. The taxonomy of some Indo-Pacific mollusca: Part 6. *Records of the Auckland Institute and Museum*, pp.67-86. Cernohorsky, W.O. 1980. The taxonomy of some Indo-Pacific Mollusca: Part 7. *Records of the Auckland Institute and Museum*, pp.171-187.

[41] Guille, A., Laboute, P. and Menou, J.L. 1986. Guide des étoiles de mer, oursins et autres échinodermes du lagon de Nouvelle-Calédonie. Paris: Éditions de l'ORSTOM.

[42] Preston, G.L., 1993. Beche-de-mer. In. Wright, A. and Hill, L. Eds. *Nearshore marine resources of the South Pacific: Information for fisheries development and management.* Forum Fisheries Agency, Honiara, Solomon Islands. Pages 371-401; Adams, T. 1992. Resource aspects of the Fiji beche-de-mer industry. *SPC Beche-de-Mer Information Bulletin* No. 4, July 1992, pp: 13-16. http:// www.spc.int/ DigitalLibrary/ Doc/ FAME/InfoBull/BDM/4/BDM4_13_Adams.pdf; Adams, T. 1993. Management of beche-de-mer (sea cucumber) fisheries. *SPC Beche-de-Mer Information Bulletin* No., 5, pp: 15-16; Ram, R., Chand, R.V. and Southgate, P.C. 2016. An overview of sea cucumber fishery management in the Fiji Islands. *Journal of Fisheries and Aquatic Science*, *11*(3), pp.191-205.

[43] Pratchett M.S. et al. 2011. Vulnerability of coastal fisheries in the tropical Pacific to climate change. In: Bell J.D., Johnson, J.E. and Hobday, A.J. 2011. *Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change*. Pages 493-576. Secretariat of the Pacific Community, Noumea, New Caledonia. 941 pages.

[44] Lewis, A.D. 1988. The penaeid shrimp resources of the Pacific Islands. Unpublished manuscript; Gwyther, D. 1982. Yield estimates for the banana prawn (*Penaeus merguiensis* de Man) in the Gulf of Papua prawn fishery. *ICES Journal of Marine Science*, *40*(3), pp.245-258; Evans, C.R., Opnai, L.J. and Kare, B.D. 1997. Fishery ecology and oceanography of the prawn *Penaeus merguiensis* (de Man) in the Gulf of Papua: estimation of maximum sustainable yield and modelling of yield, effort and rainfall. *Marine and Freshwater Research*, *48*(3), pp.219-228.

[45] Choy, S.C. The Fishery and Biology of *Penaeus canaliculatus*. *Aquat. Sci*, *447*, pp.1375-1379.

[46] Braley, R.D. 1979. Penaeid prawns in Fanga uta lagoon, Tongatapu. *Pacific Sc*. 33(3): 315- 321.

[47] Pratchett, M.S., Munday, P.L., Graham, N.A.J., Kronen, M., Pinca, S., Friedman, K., Brewer, T.D., Bell, J.D., Wilson, S.K. Cinner, J.E., Kinch, J.P., Lawton, R.J., Williams, A.J., Chapman, L., Magron, F. and Webb, A. 2011. Vulnerability of coastal fisheries in the tropical Pacific to climate change. In: Bell, J.D., Johnson, J.E. and Hobday,

A.J. (Eds.) *Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change*. Pages 493-567. Secretariat of the Pacific Community, Noumea, New Caledonia.

[48] Bell J.D., Johnson, J.E. and Hobday, A.J. 2011. Vulnerability of tropical Pacific fisheries and aquaculture to climate change. Secretariat of the Pacific Community, Noumea, New Caledonia. 941 pages.

[49] SPC. 2024. Assessment of the vulnerability of Pacific Island communities and economies to the effects of climate change on fisheries. Prepared in support of a Funding Proposal to the Green Climate Fund, *Adapting tuna-dependent Pacific Island communities and economies to climate change*. Secretariat of the Pacific Community, Noumea, New Caledonia. Technical Study 1. 121 pages + appendices. https://fame1.spc.int/documents-in-support-funding-proposal-green-climate-fund-regional-tuna-programme

[50] SPC. 2008. Status Report: Nearshore and Reef Fisheries and Aquaculture. Secretariat of the Pacific Community, Noumea, New Caledonia. www.spc.int/mrd/ministers/2008/ MIN4WP03-coastal-isheries-status-annex-a.pdf.

[51] Gillett, R. 2009. *Fisheries in the Economies of Pacific Island Countries and Territories*. Pacific Studies Series, Asian Development Bank, Manila, Philippines.

[52] Kinch, J. 2001. Clam harvesting, the Convention on the International Trade in Endangered Species (CITES) and conservation in the Milne Bay Province, Papua New Guinea. Secretariat of the Pacific Community Fisheries Newsletter 99, 24–36.

[53] SPC. 2008. Status Report: Nearshore and Reef Fisheries and Aquaculture. Secretariat of the Pacific Community, Noumea, New Caledonia. www.spc.int/mrd/ministers/2008/ MIN4WP03-coastal-fisheries-status-annex-a.pdf.

[54] Dalzell, P.J. and Shug, D. 2002. Synopsis of information relating to sustainable coastal fisheries. In: Wright, A. and Stacey, N. (Eds.). *Issues for Community-based Sustainable Resource Management and Conservation: Considerations for the Strategic Action Programme for the International Waters of the Pacific Small Island Developing States*. Volume 4. *Technical Report 2002/04*. Secretariat for the Pacific Regional Environment Programme (SPREP). Apia, Samoa, 41 pages.

[55] Pratchett, M.S., Munday, P.L., Graham, N.A.J., Kronen, M., Pinca, S., Friedman, K., Brewer, T.D., Bell, J.D., Wilson, S.K. Cinner, J.E., Kinch, J.P., Lawton, R.J., Williams, A.J., Chapman, L., Magron, F. and Webb, A. 2011. Vulnerability of coastal fisheries in the tropical Pacific to climate change. In: Bell, J.D., Johnson, J.E. and Hobday, A.J. (Eds.) *Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change*. Pages 493-567. Secretariat of the Pacific Community, Noumea, New Caledonia.

[56] Wright, A. 1993. Shallow water reef-associated finfish. In: Wright, A. and Hill, L. (Eds.). *Nearshore Marine Resources of the South Pacific*. Institute of Pacific Studies, University of the South Pacific and Pacific Islands Forum Fisheries Agency, Honiara, Solomon Islands. 710 pages; Wright, A. and Richards, A. 1983. A multispecies fishery associated with coral reefs in the Tigak Islands, Papua New Guinea. *Asian Marine Biology* 2, 69-84; Dalzell, P.J. 1996. Selectivity and yields of reef fishing. In: Polunin, N.V.C. and Roberts, C.M. (Eds.), *Reef Fisheries*. Chapman & Hall (Chapman & Hall Fish and Fisheries Series 20), London. 477 pages.

[57] Wright, A. 1993. Shallow water reef-associated finfish. In: Wright, A. and Hill, L. (Eds.). *Nearshore Marine Resources of the South Pacific*. Institute of Pacific Studies, University of the South Pacific and Pacific Islands Forum Fisheries Agency, Honiara, Solomon Islands. 710 pages.

[58] Govan, H., 2017. Ocean governance–our sea of islands. In: Katafono, R. (Ed.). *A Sustainable Future for Small States: Pacific 2050*. Commonwealth Secretariat London. Pages 163-234.

[59] Adams, T., Dalzell, P. and Farman, R. 1996. Status of Pacific Island coral reef fisheries. SPC Coastal Fisheries Programme. Secretariat of the Pacific Community, Noumea, New Caledonia. Paper presented at 8th International Coral Reef Symposium, Panama, 1996. 7 pages.

[60] Pinca, S., Kronen, M., Friedman, K., Magron, F., Chapman, L., Tardy, E., Pakoa, K., Awira, R., Boblin, P. and Lasi, F. 2010. Regional assessment report: Profiles and results from survey work at 63 sites across 17 Pacific Island countries and territories (1 March 2002 to 31 December 2009). Noumea, New Caledonia: Secretariat of the Pacific Community. 512 pages.

[61] Gillett R. and Fong, M. 2024. Fisheries in the economies of Pacific Island countries and territories (Benefish Study 4). Noumea, New Caledonia: Pacific Community.

[62] Chapman L, Pasisi B, Bertram I, Beverly S and Sokimi W (2005) *Manual on Fish Aggregating Devices (FADs): Lower-Cost Moorings and Programme Management*. Secretariat of the Pacific Community, Noumea, New Caledonia.

[63] Sharp, M. 2011. The benefits of fish aggregating devices in the Pacific. SPC Fisheries Newsletter 135:28-36.

[64] Adams, T. and Dalzell, P.J. 1995. Management of Pacific Island inshore fisheries. 3rd Australasian Fisheries Managers Conference, 2-4 August 1995, Rottnest Island, Western Australia. Integrated Coastal Fisheries Management Project, South Pacific Commission, BP D5, 98848 Nouméa Cedex, New Caledonia. 8 pages.

[65] Bell, J.D., Ganachaud, A., Gehrke, P.C., Griffiths, S.P., Hobday, A.J., Hoegh-Guldberg, O. et al. 2013. Mixed responses of tropical Pacific fisheries and aquaculture to climate change. *Nat Climate Change* 2013:3:591–9.

[66] Adams, T., Dalzell, P. and Farman, R. 1996. Status of Pacific Island coral reef fisheries. SPC Coastal Fisheries Programme. Secretariat of the Pacific Community, Noumea, New Caledonia. Paper presented at 8th International Coral Reef Symposium, Panama, 1996. 7 pages.

[67] Bell, J.D., Kronen, M., Vunisea, A., Nash, W.J., Keeble, G., Demmke, A., Pontifex, S., Andréfouët, S. 2009. Planning the use of fish for food security in the Pacific. *Mar. Pol*. 33 (1), 64–76.

[68] Pinca, S., Kronen, M., Friedman, K., Magron, F., Chapman, L., Tardy, E., Pakoa, K., Awira, R., Boblin, P. and Lasi, F. 2009. Pacific Regional Oceanic and Coastal Fisheries Development Programme (ProcFish/C/CoFish: Regional assessment report.

[69] Preston, G.L., 1993. Beche-de-mer. In. Wright, A. and Hill, L. Eds. *Nearshore marine resources of the South Pacific: Information for fisheries development and management.* Forum Fisheries Agency, Honiara, Solomon Islands. Pages 371-401. Adams, T. 1992. Resource aspects of the Fiji beche-de-mer industry. *SPC Beche-de-Mer Information Bulletin* No. 4, July 1992, pp: 13-16. http:// www.spc.int/ DigitalLibrary/ Doc/ FAME/InfoBull/BDM/4/BDM4_13_Adams.pdf. Adams, T. 1993. Management of beche-de-mer (sea cucumber) fisheries. *SPC Beche-de-Mer Information Bulletin* No., 5, pp: 15-16. Ram, R., Chand, R.V. and Southgate, P.C. 2016. An overview of sea cucumber fishery management in the Fiji Islands. *Journal of Fisheries and Aquatic Science*, *11*(3), pp.191-205.

[70] Much of the following material is drawn from: Williams, P. and Ruaia, T. 2023. Overview of tuna fisheries in the Western and Central Pacific Ocean including economic conditions – 2022. Western and Central Pacific Fisheries Commission, Scientific Committee, Nineteenth Regular Session, Koror, Palau, 16 –24 August 2023. WCPFC-SC19-2023/GN WP-1. 65 pages.

[71] Bell, J.D., Senina, I., Adams, T., Aumont, O., Calmettes, B., Clark, S., Dessert, M., Gehlen, M., Gorgues, T., Hampton, J. and Hanich, Q., 2021. Pathways to sustaining tuna-dependent Pacific Island economies during climate change. *Nature sustainability*, *4*(10), pp.900-910.

[72] Bell, J.D., Bright, P., Gillett, B., Keeble, G., Kronen, M., Passfield, K. and Ryan, C. 2008. Importance of household income and expenditure surveys and censuses for management of coastal and freshwater fisheries. SPC Fisheries Newsletter #127 – October/December 2008. Secretariat of the Pacific Community, Noumea, New Caledonia. Pages 34-39.

[73] Gillett R. 2009. Fisheries in the economies of Pacific Island countries and territories. Asian Development Bank. Mandaluyong City: Philippines. 483 pages.
https://www.adb.org/sites/default/files/publication/27511/pacific-fisheries.pdf (for 2007)

[74] and Gillett R. 2016. Fisheries in the economies of Pacific Island countries and territories. Noumea, New Caledonia: Pacific Community. 684 p. https://purl.org/spc/digilib/doc/pvyuo (for 2014)

[75] Gillett R. and Fong, M. *2024*. Fisheries in the economies of Pacific Island countries and territories (Benefish Study 4). Noumea, New Caledonia: Pacific Community (for 2021)

[76] Gillett R. 2016. Fisheries in the economies of Pacific Island countries and territories. Noumea, New Caledonia: Pacific Community. 684 p. https://purl.org/spc/digilib/doc/pvyuo (for 2014)

[77] Gillett R. and Fong, M. 2024. Fisheries in the economies of Pacific Island countries and territories (Benefish Study 4). Noumea, New Caledonia: Pacific Community.

[78] Bell, J.D., Cisneros-Montemayor, A., Hanich, Q., Johnson, J.E., Lehodey, P., Moore, B.R., Pratchett, M.S., Reygondeau, G., Senina, I., Virdin, J. and Wabnitz, C.C., 2018. Adaptations to maintain the contributions of small-scale fisheries to food security in the Pacific Islands. *Marine Policy*, *88*, pp.303-314.

[79] Pratchett, M.S., Munday, P.L., Graham, N.A.J., Kronen, M., Pinca, S., Friedman, K., Brewer, T.D., Bell, J.D., Wilson, S.K. Cinner, J.E., Kinch, J.P., Lawton, R.J., Williams, A.J., Chapman, L., Magron, F. and Webb, A. 2011. Vulnerability of coastal fisheries in the tropical Pacific to climate change. In: Bell, J.D., Johnson, J.E. and Hobday, A.J. (Eds.) *Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change*. Pages 493-567. Secretariat of the Pacific Community, Noumea, New Caledonia.

[80] Bell, J.D., Cisneros-Montemayor, A., Hanich, Q., Johnson, J.E., Lehodey, P., Moore, B.R., Pratchett, M.S., Reygondeau, G., Senina, I., Virdin, J. and Wabnitz, C.C., 2018. Adaptations to maintain the contributions of small-scale fisheries to food security in the Pacific Islands. *Marine Policy*, *88*, pp.303-314.

[81] Pinca, S., Kronen, M., Friedman, K., Magron, F., Chapman, L., Tardy, E., Pakoa, K., Awira, R., Boblin, P. and Lasi, F. 2010. Regional assessment report: Profiles and results from survey work at 63 sites across 17 Pacific Island countries and territories (1 March 2002 to 31 December 2009). Noumea, New Caledonia: Secretariat of the Pacific Community. 512 pages.

[82] Shredrawi, G. et al. 2024. Leveraging deep learning and computer vision technologies to enhance management of coastal fisheries in the Pacific region. *Scientific Reports* 14, Article number: 20915

[83] Pratchett, M.S., Munday, P.L., Graham, N.A.J., Kronen, M., Pinca, S., Friedman, K., Brewer, T.D., Bell, J.D., Wilson, S.K. Cinner, J.E., Kinch, J.P., Lawton, R.J., Williams, A.J., Chapman, L., Magron, F. and Webb, A. 2011. Vulnerability of coastal fisheries in the tropical Pacific to climate change. In: Bell, J.D., Johnson, J.E. and Hobday, A.J. (Eds.) *Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change*. Pages 493-567. Secretariat of the Pacific Community, Noumea, New Caledonia.

[84] Bell, J.D., Cisneros-Montemayor, A., Hanich, Q., Johnson, J.E., Lehodey, P., Moore, B.R., Pratchett, M.S., Reygondeau, G., Senina, I., Virdin, J. and Wabnitz, C.C., 2018. Adaptations to maintain the contributions of small-scale fisheries to food security in the Pacific Islands. *Marine Policy*, *88*, pp.303-314.

[85] Williams, P. and Ruaia, T. 2023. Overview of tuna fisheries in the Western and Central Pacific Ocean including economic conditions – 2022. Western and Central Pacific Fisheries Commission, Scientific Committee, Nineteenth Regular Session, Koror, Palau, 16 –24 August 2023. WCPFC-SC19-2023/GN WP-1. 65 pages.

[86] Data from: SPC. 2022. Tuna Fishery Yearbook: 2021. Oceanic Fisheries Programme Pacific Community Noumea, New Caledonia Western and Central Pacific Fisheries Commission, Pohnpei, Federated States of Micronesia http://www.wcpfc.int 164 pages.

[87] Gillett, R. 2009. *Fisheries in the Economies of Pacific Island Countries and Territories*. Pacific Studies Series, Asian Development Bank, Manila, Philippines.

[88] Johannes, R.E., 1981. *Words of the lagoon: fishing and marine lore in the Palau district of Micronesia*. Univ of California Press. 245 pages.

[89] Yeeting, B. and Wright, A. 1989. A review of the status of fisheries resources in Tarawa Lagoon, Republic of Kiribati", *FFA Report No. 89/16(a)*, Forum Fisheries Agency, Honiara, Solomon Islands.

[90] Anon. 1988. The marine resources of Palmerston Atoll, Cook Islands. Inshore Fisheries Research Project, South Pacific Commission, Noumea, New Caledonia. Unpubl. Report.

[91] Adams, T., Dalzell, P. and Farman, R. 1996. Status of Pacific Island coral reef fisheries. SPC Coastal Fisheries Programme. Secretariat of the Pacific Community, Noumea, New Caledonia. Paper presented at 8th International Coral Reef Symposium, Panama, 1996. 7 pages.

[92] Helm, N. 1992. A report on a market survey of reef and lagoon fishes in Western Samoa. In: Dalzell, P.J. Papers on fisheries science from the Pacific Islands. Vol. 1. Inshore Fisheries Research Project, *Technical Document No. 1.* South Pacific Commission, Noumea, New Caledonia. pp. 1-5.

[93] Hughes, T.P., Baird, A.H., Bellwood, D.R., Card, M. and others. 2003. Climate change, human impacts and the resilience of coral reefs. *Science* 301, 929–933. Bellwood, D.R., Hughes, T.P., Folke, C. and Nyström, M. 2004. Confronting the coral reef crisis. *Nature* 429, 827–833.

[94] Wright, A. 1993. Shallow water reef-associated finfish. In: Wright, A. and Hill, L. (Eds.). *Nearshore Marine Resources of the South Pacific*. Institute of Pacific Studies, University of the South Pacific and Pacific Islands Forum Fisheries Agency, Honiara, Solomon Islands. 710 pages

[95] Waycott, M., McKenzie, L.J., Mellors, J.E., Ellison, J.C., Sheaves, M.T., Collier, C., Schwarz, A-M., Webb, A., Johnson, J.E. and Payri, C.E. 2011. Vulnerability of mangroves, seagrasses and intertidal flats in the tropical Pacific to climate change. In: Bell J.D., Johnson, J.E. and Hobday, A.J. 2011. *Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change*. Pages 297-358. Secretariat of the Pacific Community, Noumea, New Caledonia. 941 pages.

[96] SPC. 2024. Assessment of the vulnerability of Pacific Island communities and economies to the effects of climate change on fisheries. Prepared in support of a Funding Proposal to the Green Climate Fund, *Adapting tuna-dependent Pacific Island communities and economies to climate change*. Secretariat of the Pacific Community, Noumea, New Caledonia. Technical Study 1. 121 pages + appendices. https://fame1.spc.int/documents-in-support-funding-proposal-green-climate-fund-regional-tuna-programme

[97] Hughes, T.P., Baird, A.H., Bellwood, D.R., Card, M. and others. 2003. Climate change, human impacts and the resilience of coral reefs. *Science* 301, 929–933. Bellwood, D.R., Hughes, T.P., Folke, C. and Nyström, M. 2004. Confronting the coral reef crisis. *Nature* 429, 827–833.

[98] Hughes, T.P., Rodrigues, M.J., Bellwood, D.R., Ceccarelli, D. and others. 2007. Phase shifts, herbivory, and the resilience of coral reefs to climate change. *Current Biology* 17, 360–365. Hughes, T.P., Graham, N.A.J., Jackson, J.B.C., Mumby, P.J. and Steneck, R.S. 2010. Rising to the challenge of sustaining coral reef resilience. *Trends in Ecology and Evolution* 25, 633–642.

[99] Pratchett M.S. et al. 2011. Vulnerability of coastal fisheries in the tropical Pacific to climate change. In: Bell J.D., Johnson, J.E. and Hobday, A.J. 2011. *Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change*. Pages 493-576. Secretariat of the Pacific Community, Noumea, New Caledonia. 941 pages.

[100] Pratchett M.S. et al. 2011. Vulnerability of coastal fisheries in the tropical Pacific to climate change. In: Bell J.D., Johnson, J.E. and Hobday, A.J. 2011. *Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change*. Pages 493-576. Secretariat of the Pacific Community, Noumea, New Caledonia. 941 pages.

[101] Pinca, S., Kronen, M., Friedman, K., Magron, F., Chapman, L., Tardy, E., Pakoa, K., Awira, R., Boblin, P. and Lasi, F. 2010. Regional assessment report: Profiles and results from survey work at 63 sites across 17 Pacific Island countries and territories (1 March 2002 to 31 December 2009). Noumea, New Caledonia: Secretariat of the Pacific Community. 512 pages.

[102] Newton, K., Cote, I.M., Pilling, G.M., Jennings, S. and Dulvy, N.K. 2007. Current and future sustainability of island coral reef fisheries. *Current Biology* 17, 655–658.

[103] Dalzell, P. 1996. Selectivity and yields of reef fishing. In: Polunin, N. and Roberts, C. (Eds.). *Reef Fisheries*. Chapman and Hall, London.

[104] Polunin, N., Roberts, C.M., and Pauly, D. 1996. Developments in tropical reef fisheries science and management. In: Polunin, N. and Roberts, C. (Eds.) *Reef Fisheries*. Chapman and Hall, London.

[105] Dalzell, P.J. and Shug, D. 2002. Synopsis of information relating to sustainable coastal fisheries. In: Wright, A. and Stacey, N. (Eds.). *Issues for Community-based Sustainable Resource Management and Conservation: Considerations for the Strategic Action Programme for the International Waters of the Pacific Small Island Developing States*. Volume 4. *Technical Report 2002/04*. Secretariat for the Pacific Regional Environment Programme (SPREP). Apia, Samoa, 41 pages.

[106] Munro, J.L. 1999. Effects of fishing on coral reef ecosystems. In: Schei, P.J., Sandlund, O.T. and Strand, R. (Eds.) *Proceedings of the Norway/UN Conference on the Ecosystem Approach to Sustainable Use of Biological Diversity*. Norwegian Directorate for Nature Management and Norwegian Institute for Nature Research, Trondheim.

[107] Pinca, S., Kronen, M., Magron, F., McArdle, B. et al. 2011. Relative importance of habitat and fishing in influencing reef fish communities across seventeen Pacific Island Countries and Territories. *Fish and Fisheries*, doi: 10.111/j.1467-2979.2011.00425.

[108] Kronen, M., Magron, F., McArdle, B. and Vunisea, A. 2010. Reef fishing pressure risk model for Pacific Island countries and territories. *Fisheries Research* 101, 1–10.

[109] Primarily drawn from: Hare, S.R., Williams, P.G., Jordan, C.C., Hamer, P.A., Hampton, W.J., Lehodey, P., Macdonald, J., Scott, R.D., Scutt Phillips, J., Senina, I. and Pilling, G.M. 2021. The western and central Pacific tuna fishery: 2021 overview and status of stocks. Secretariat of the Pacific Community, Oceanic Fisheries Programme. *Tuna Fisheries Assessment Report* no. 22. Noumea, New Caledonia, 2022. 63 pages. https://purl.org/spc/digilib/doc/8izba

[110] Castillo Jordán, C., Teears, T., Hampton, J., Davies, N., Scutt Phillips, J., McKechnie, S., Peatman, T., MacDonald, J., Day, J., Magnusson, A., Scott, R., F. Scott, F., Pilling, G. and Hamer, P. 2022. Stock assessment of skipjack tuna in the western and central Pacific Ocean: 2022. WCPFC Scientific Committee, Eighteenth Regular Session, 10–18 August 2022. WCPFC-SC18-2022/SA-WP-01. Rev. 5. 155 pages.

[111] Vincent, M., Ducharme-Barth, N., Hamer, P., Hampton, J., Williams, P. and Pilling, G. 2020. Stock assessment of yellowfin tuna in the western and central Pacific Ocean. WCPFC 16th Regular Session of the Scientific Committee, Electronic Meeting, 12-19 August 2020. WCPFC-SC16-2020/SA-WP-04-Rev3. 154 pages.

[112] Ducharme-Barth, N., Vincent, M., Hampton, J., Hamer, P., Williams, P. and Pilling, G. 2020. Stock assessment of bigeye tuna in the western and central Pacific Ocean. 16th Regular Session of the WCPFC Scientific Committee, Electronic Meeting, 12-19 August 2020. WCPFC-SC16-2020/SA-WP-03 [REV3]. 147 pages.

[113] McKechnie, S., Pilling, G. and J. Hampton, J. 2017. Stock assessment of bigeye tuna in the western and central Pacific Ocean. 13th Regular Session of the WCPFC Scientific Committee, Rarotonga, Cook Islands, 9-17 August 2017. WCPFC-SC13-2017/SA-WP-05Rev1. 147 pages.

[114] Castillo-Jordan, C., Xu, H., Hampton, J., Ducharme-Barth, N., and Hamer, P. 2021. Stock assessment of South Pacific albacore. Seventeenth Regular Session of the WCPFC Scientific Committee. Electronic Meeting, 11-19 August 2021. WCPFC-SC17-2021/SA-WP-02. 108 pages.

[115] Tremblay-Boyer, L., Hampton, J., McKechnie, S., and Pilling, G. 2018. Stock assessment of South Pacific albacore tuna. Fourteenth Regular Session of the WCPFC Scientific Committee, Busan, South Korea, 8-16 August 2018. WCPFC-SC-14-2018/SA-WP-05.

[116] SPC. 2008. Fish and Food Security. SPC Policy Brief 1/2008 https://pacificdata.org/data/dataset/oai-www-spc-int-ced24e95-7e0a-401a-9f0b-d79316c49cb0; see also SPC. 2007. The Future of Pacific Fisheries – Planning and Managing for Economic Growth, Food Security and Sustainable Livelihoods. *5th Conference of the Pacific Community*, Apia, Samoa, 12–13 November 2007.

[117] See: Brewer T., Kottage H., Andrew N. *in prep*. Options for supplying dietary protein for growing Pacific Island populations. Report prepared for the Pacific Community. 93 p. https://purl.org/spc/digilib/doc/4aszp

[118] FFA and SPC. 2014. A Regional Roadmap for Sustainable Pacific Fisheries. https://www.spc.int/DigitalLibrary/Doc/FAME/Brochures/FFA_SPC_2015_Roadmap.pdf

[119] Bell, J.D., Kronen, M., Vunisea, A., Nash, W.J., Keeble, G., Demmke, A., Pontifex, S. and Andréfouët, S. 2009. Planning the use of fish for food security in the Pacific. *Marine Policy*, *33*, 64-76 and Bell, J.D., Allain, A., Allison, E.H., Andréfouët, S., Andrew, N.L. *et al*. 2015 Diversifying the use of tuna to improve food security and public health in Pacific Island countries and territories, *Marine Policy* 51, 584–591.

[120] SPC. 2008. Fish and Food Security. *Policy Brief*, 1/2008. Noumea, New Caledonia: Secretariat of the Pacific Community. 4 pages.

[121] SPC Statistics for Development Division. Noumea, New Caledonia.

[122] Bell, J.D., Allain, A., Allison, E.H., Andréfouët, S., Andrew, N.L. *et al*. 2015. Diversifying the use of tuna to improve food security and public health in Pacific Island countries and territories, *Marine Policy* 51 (2015) 584–591.

[123] SPC. 2024. Assessment of the vulnerability of Pacific Island communities and economies to the effects of climate change on fisheries. Prepared in support of a Funding Proposal to the Green Climate Fund, *Adapting tuna-dependent Pacific Island communities and economies to climate change*. Secretariat of the Pacific Community, Noumea, New Caledonia. Technical Study 2. https://fame1.spc.int/documents-in-support-funding-proposal-green-climate-fund-regional-tuna-programme

[124] See Technical Study 2 (Table 17) at https://fame.spc.int/documents-in-support-funding-proposal-green-climate-fund-regional-tuna-programme

[125] Gillett R. and Fong, M. 2024. Fisheries in the economies of Pacific Island countries and territories (Benefish Study 4). Noumea, New Caledonia: Pacific Community.

[126] Bell, J.D., Kronen, M., Vunisea, A., Nash, W.J., Keeble, G., Demmke, A., Pontifex, S. and Andréfouët, S. 2009. Planning the use of fish for food security in the Pacific. *Marine Policy*, *33*(1), pp.64-76.

[127] FAO Fisheries and Aquaculture Department. 2012. The state of world fisheries and aquaculture 2012. Rome: Food and Agriculture Organization of the United Nations.

[128] Bell, J.D., Kronen, M., Vunisea, A., Nash, W.J., Keeble, G., Demmke, A., Pontifex, S., Andréfouët, S. 2009. Planning the use of fish for food security in the Pacific. *Mar. Pol*. 33 (1), 64–76.

[129] Bell, J.D., Allain, A., Allison, E.H., Andréfouët, S., Andrew, N.L. *et al*. 2015 Diversifying the use of tuna to improve food security and public health in Pacific Island countries and territories, *Marine Policy* 51 (2015) 584–591.

[130] Bell, J.D., Kronen, M., Vunisea, A., Nash, W.J., Keeble, G., Demmke, A., Pontifex, S., Andréfouët, S. 2009. Planning the use of fish for food security in the Pacific. *Mar. Pol*. 33 (1), 64–76.

[131] Bell, J.D., Kronen, M., Vunisea, A., Nash, W.J., Keeble, G., Demmke, A., Pontifex, S. and Andréfouët, S. 2009. Planning the use of fish for food security in the Pacific. *Marine Policy*, *33*(1), pp.64-76.

[132] FAO. 2022. The State of World Fisheries and Aquaculture 2022. Towards Blue Transformation. Rome, FAO. https://doi.org/10.4060/cc0461en

[133] Bell, J.D., Kronen, M., Vunisea, A., Nash, W.J., Keeble, G., Demmke, A., Pontifex, S. and Andréfouët, S. 2009. Planning the use of fish for food security in the Pacific. *Marine Policy*, *33*(1), pp.64-76.

[134] Bell, J.D., Kronen, M., Vunisea, A., Nash, W.J., Keeble, G., Demmke, A., Pontifex, S. and Andréfouët, S. 2009. Planning the use of fish for food security in the Pacific. *Marine Policy*, *33*(1), pp.64-76.

[135] Brewer T., Kottage H., Andrew N. *in prep*. Options for supplying dietary protein for growing Pacific Island populations. Technical Report prepared for the Pacific Community in support of the preparation of a Funding Proposal for the Green Climate Fund. 93 pages. https://fame1.spc.int/documents-in-support-funding-proposal-green-climate-fund-regional-tuna-programme

[136] SPC. 2024. Assessment of the vulnerability of Pacific Island communities and economies to the effects of climate change on fisheries. Prepared in support of a Funding Proposal to the Green Climate Fund, *Adapting tuna-dependent Pacific Island communities and economies to climate change*. Secretariat of the Pacific Community, Noumea, New Caledonia. Technical Study 2. https://fame1.spc.int/documents-in-support-funding-proposal-green-climate-fund-regional-tuna-programme

[137] Brewer T., Kottage H., Andrew N. *in prep*. Options for supplying dietary protein for growing Pacific Island populations. Technical Study 2 prepared for the Pacific Community in support of the preparation of a Funding Proposal for the Green Climate Fund. 93 pages. https://fame1.spc.int/documents-in-support-funding-proposal-green-climate-fund-regional-tuna-programme

[138] Bell, J.D., Kronen, M., Vunisea, A., Nash, W.J., Keeble, G., Demmke, A., Pontifex, S. and Andréfouët, S. 2009. Planning the use of fish for food security in the Pacific. *Marine Policy*, *33*(1), pp.64-76.

[139] FAO. 2008. State of World Aquaculture and Fisheries 2008. Food and Agriculture Organization of the United Nations, Rome, Italy. www.fao.org/docrep/011/i0250e/i0250e00.htm.

[140] Charlton, K.E., Russell, J., Gorman, E., Hanich, Q., Delisle, A., Campbell, B. and Bell, J. 2016. Fish, food security and health in Pacific Island countries and territories: a systematic literature review. *BMC Public Health*, *16*(1), pp.1-26.

[141] Aswani, S. and Furusawa, T. Do marine protected areas affect human nutrition and health? A comparison between villages in Roviana, Solomon Islands. *Coast Manag*. 2007;35(5):545–65. 53.

[142] Hedges, R., Rush, E. and Aalbersberg, W. 2009. Correspondence between human diet, body composition and stable isotopic composition of hair and breath in Fijian villagers. *Isot Environ Health Stud*. 2009:45(1):1–17.

[143] Kuster, C., Vuki, V.C. and Zann, L.P. 2005. Long-term trends in subsistence fishing patterns and coral reef fisheries yield from a remote Fijian island. *Fish Res.* 2005;76(2): 221–8.

[144] Gillett R. and Fong, M. *2024*. Fisheries in the economies of Pacific Island countries and territories (Benefish Study 4). Noumea, New Caledonia: Pacific Community.

[145] Kawarazuka, N. and Bene, C. 2010. Linking small-scale fisheries and aquaculture to household nutritional security: An overview. *Food Security* 2, 343–357.

[146] Pratchett, M.S., Munday, P.L., Graham, N.A.J., Kronen, M., Pinca, S., Friedman, K., Brewer, T.D., Bell, J.D., Wilson, S.K. Cinner, J.E., Kinch, J.P., Lawton, R.J., Williams, A.J., Chapman, L., Magron, F. and Webb, A. 2011. Vulnerability of coastal fisheries in the tropical Pacific to climate change. In: Bell, J.D., Johnson, J.E. and Hobday, A.J. (Eds.) *Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change*. Pages 493-567. Secretariat of the Pacific Community, Noumea, New Caledonia.

[147] Bell, J.D., Kronen, M., Vunisea, A., Nash, W.J., Keeble, G., Demmke, A., Pontifex, S. and Andréfouët, S. 2009. Planning the use of fish for food security in the Pacific. *Marine Policy*, *33*(1), pp.64-76.

[148]Bell, J.D., Reid, C., Batty, M.J., Allison, E.A. Lehodey, P. et al. 2011. Implications of climate change for contributions by fisheries and aquaculture to Pacific Island economies and communities. In: Bell, J.D., Johnson, J.E. and Hobday, A.J. (Eds.) *Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change*. Pages 733-802. Secretariat of the Pacific Community, Noumea, New Caledonia.

[149] Bell, J.D., Allain, A., Allison, E.H., Andréfouët, S., Andrew, N.L. *et al*. 2015. Diversifying the use of tuna to improve food security and public health in Pacific Island countries and territories, *Marine Policy* 51, 584–591.

[150] Gillett R. and Fong, M. *2024*. Fisheries in the economies of Pacific Island countries and territories (Benefish Study 4). Noumea, New Caledonia: Pacific Community.

[151] Newton, K., Cote, I.M., Pilling, G.M., Jennings, S. and Dulvy, N.K. 2007. Current and future sustainability of island coral reef fisheries. *Current Biology* 17, 655–658.

[152] Bell, J.D., Andrew, N.L., Batty, M.J., Chapman, L.B. et al. 2011.Adapting tropical Pacific fisheries and aquaculture to climate change:Management measures, policies and investments, In: Bell J.D., Johnson, J.E. and Hobday, A.J. 2011. *Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change*. Pages 803-874. Secretariat of the Pacific Community, Noumea, New Caledonia. 941 pages.

[153] SPC. 2017. SPC Policy Brief #31: Sustainable national artisanal FAD programmes: what to aim for. Noumea, New Caledonia: Pacific Community. 4 pages. https:// purl.org/spc/digilib/doc/5hzi8

[154] Bell, J.D., Allain, A., Allison, E.H., Andréfouët, S., Andrew, N.L. *et al*. 2015. Diversifying the use of tuna to improve food security and public health in Pacific Island countries and territories, *Marine Policy* 51, 584–591.

[155] Andrew, N. L., Allison, E.H. Brewer, T., Connell, J., Eriksson, H., Eurich, J.G. Farmery, A., Gephart, J.A., Golden, C.D. and Herrero, M. 2022. Continuity and change in the contemporary Pacific food system. *Global Food Security* 32: 100608.

[156] Brewer, T., Andrew, N., Abbott, D., Detenamo, R., Faaola, E., Gounder, P., Lal, N., Lui, K., Ravuvu, A. and Sapalojang, D. 2023. The role of trade in Pacific food security and nutrition. *Global Food Security* 36: 100670.

[157] Pickering, T.D., Ponia, B., Hair, C.a. Southgate, P.C. et al. 2011. In: Bell J.D., Johnson, J.E. and Hobday, A.J. 2011. *Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change*. Pages 647-731. Secretariat of the Pacific Community, Noumea, New Caledonia. 941 pages.

[158] Bell, J.D., Andrew, N.L., Batty, M.J., Chapman, L.B. et al. 2011.Adapting tropical Pacific fisheries and aquaculture to climate change:Management measures, policies and investments, In: Bell J.D., Johnson, J.E. and Hobday, A.J. 2011. *Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change*. Pages 803-874. Secretariat of the Pacific Community, Noumea, New Caledonia. 941 pages.

[159] Drawn from: Ruaia, T., Gu'urau, S. and Wheatley, L. 2023. Economic and Development Indicators and Statistics: Tuna Fisheries of the Western and Central Pacific Ocean 2022. Pacific Islands Forum Fisheries Agency, Honiara, Solomon Islands. 74 pages.

[160] Gillett R. and Fong, M. *2024*. Fisheries in the economies of Pacific Island countries and territories (Benefish Study 4). Noumea, New Caledonia: Pacific Community.

[161] It is reported that, in recognition of this situation, some GCF Participating Countries have approached the Fiji-based Pacific Island Financial Technical Assistance Centre (PIFTAC) for technical assistance with the preparation of their national accounts. Gillett and Fong, *in press*.

[162] Gillett R. and Fong, M. *2024*. Fisheries in the economies of Pacific Island countries and territories (Benefish Study 4). Noumea, New Caledonia: Pacific Community.

[163] SPC. 2015. *A new song for coastal fisheries pathways to change: The Noumea strategy*. Secretariat of the Pacific Community. Noumea, New Caledonia. 28 pages.

[164] Forum Communiqué, 48th Pacific Islands Forum, Apia, Samoa, 5-8 September, 2017. http://www.forumsec.org/wp-content/uploads/2018/02/Final_48-PIF-Communique_2017_14Sep17.pdf

[165] SPREP – Pacific Regional Environment Programme. PIFS – Pacific Islands Forum Secretariat.

[166] Broader than the membership of FFA, the 19 members of the RFMM are: Australia, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Kiribati, Marshall Islands, Nauru, New Caledonia, New Zealand, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu and Vanuatu.

[167] Govan, H., Tawake, A., Tabunakawai, K., Jenkins, A., Lasgorceix, A., Techera, E., Tafea, H., Kinch, J., Feehely, J., Ifopo, P., Hills, R., Alefaio, S., Meo, S., Troniak, S., Malimali, S., George, S., Tauaefa, T. and Obed, T. 2009. *Community Conserved Areas: A review of status and needs in Melanesia and Polynesia*. ICCA regional review for CENESTA /TILCEPA /TGER /IUCN/ GEF-SGP. Secretariat of the Pacific Regional Environment Programme (SPREP), Apia, Samoa. 66 pages.

[168] Townsley, P., Anderson, J. and Mees, C. 1997. Customary marine tenure in the South Pacific: the uses and challenges of mapping. *PLA Notes* 30:36-39. Institute of Development Studies (IIED), 3 Endsleigh Street, London, WC1H 0DD.

[169] Used interchangeably with other terms such as "customary marine tenure", ''traditional marine tenure'' and ''customary conserved areas''.

[170] Hviding, E., 1998. Contextual flexibility: present status and future of customary marine tenure in Solomon Islands. *Ocean & Coastal Management*, *40*(2-3), pp.253-269; Johannes, R. E. 1978. Traditional marine conservation methods in Oceania and their demise. *Annual Review of Ecology and Systematics*. 1978, Vol. 9 (1978), pp. 349-364.

[171] Cohen, P.J. and Foale, S.J., 2013. Sustaining small-scale fisheries with periodically harvested marine reserves. *Marine Policy*, *37*: 278-287; Cinner, J., Basurto, X., Fidelman, P., Kuange, J., Lahari, R. and Mukminin, A. 2012. Institutional designs of customary fisheries management arrangements in Indonesia, Papua New Guinea, and Mexico. *Marine Policy, 36*(1), pp. 278-285; Cinner, J., Marnane, M. J., McClanahan, T. R. and Almany, G. R. 2006. Periodic closures as adaptive coral reef management in the Indo-Pacific. *Ecology and Society, 11*(1); Cinner, J. E. and Aswani, S. 2007. Integrating customary management into marine conservation. *Biological Conservation, 140*(3-4), pp. 201-216.

[172] SPC membership comprises American Samoa, Australia, Cook Islands, Federated States of Micronesia, Fiji, France, French Polynesia, Guam, Kiribati, Marshall Islands, Nauru, New Caledonia, New Zealand, Niue, Northern Mariana Islands, Palau, Papua New Guinea, Pitcairn Islands, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, United States of America, Vanuatu, and Wallis and Futuna.

[173] Clark, S., Bell, J., Adams, T., Allain, V., Aqorau, T., Hanich, Q., Jaiteh, V., Lehodey, P., Pilling, G., Senina, I., Smith, N., Williams, P. and Yeeting, A.2021. The Parties to the Nauru Agreement (PNA) 'Vessel Day Scheme': A cooperative fishery management mechanism assisting member countries to adapt to climate variability and change. In: Bahri, T., Vasconcellos, M., Welch, D.J., Johnson, J., Perry, R.I., Ma, X. and Sharma, R. (Eds.) *Adaptive management of fisheries in response to climate change*. Pages 209-224. FAO Fisheries and Aquaculture Technical Paper No. 667. Rome, FAO. https://doi.org/10.4060/cb3095en.
[174] Cook Islands, New Zealand, Niue, Samoa and Tonga
[175] A Scientific Committee (SC), a Technical and Compliance Committee (TCC) and a Northern Committee (NC). A Finance and Administration Committee (FAC) provides the Commission with advice in relation to financial matters, the budget, staff establishment and headquarters affairs among other administrative subjects.
[176] SEAPODYM is a numerical model initially developed for investigating physical-biological interaction between tuna populations and the pelagic ecosystem of the Pacific Ocean. Using predicted environment from ocean-biogeochemical models, SEAPODYM integrates spatio-temporal and multi-population dynamics and considers interactions among populations of different species and between populations and their physical and biological environment (including intermediate trophic levels). The model also includes a description of multiple fisheries and then predicts spatio-temporal distribution of catch rates, and length-frequencies of catch based either on observed or simulated fishing effort, allowing respectively to evaluate the model or to test management options (e.g., changing the fishing effort, implementing marine reserves).
[177] Summary Report, 19th Regular Session of the Western and Central Pacific Fisheries Commission, para 342-343. Da Nag, Vietnam, 27 November – 3 December 2022.
[178] Summary Report, 19th Regular Session of the Western and Central Pacific Fisheries Commission, para 103-111 and 342-343. Da Nag, Vietnam, 27 November – 3 December 2022.