

## Realising the food security benefits of canned fish for Pacific Island countries

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### A B S T R A C T

Canned fish is a healthy alternative to the poor-quality, imported, processed foods implicated in the rise of non-communicable diseases in Pacific Island countries. Increased availability and consumption of canned fish also promises to help fill the gap between sustainable coastal fish production and recommended intake of fish for good nutrition. This study estimates the recent contribution of canned products to fish supply in Fiji, Papua New Guinea (PNG) and Solomon Islands, based on the quantities of imported and locally-produced canned fish sold on domestic markets. The greatest quantities of canned fish were sold in PNG, however, average annual consumption of canned fish per capita was highest in Fiji ( $8.8 \pm 1.3$  kg) and Solomon Islands ( $5.9 \pm 0.6$  kg), where it supplied an average of  $25 \pm 4\%$  and  $17 \pm 2\%$  of recommended dietary fish intake, respectively. Canned tuna comprised an average of  $53 \pm 2\%$  of the canned fish consumption in Fiji and  $92 \pm 1\%$  in Solomon Islands. Key actions needed to maintain/increase per capita consumption of canned fish in Pacific Island countries include promoting the health benefits of canned tuna to help combat non-communicable diseases, and facilitating distribution of locally-canned products, especially to the inland population of PNG. Increasing the market share of locally-canned tuna by assisting national canneries to obtain sufficient supplies of tuna to achieve economies of scale and compete effectively in both domestic and intra-regional canned fish trade, could create more employment and contribute indirectly to local food security.

### 1. Introduction

Pacific Island people have always had an extraordinary dependence on fish for nutrition. Even during the past two decades, as many Pacific Island countries have been undergoing a 'nutrition transition' in which traditional diets based on fresh produce are being increasingly replaced with highly-processed imported foods that are energy dense but nutrient poor [14], per capita fish consumption has typically been 2–4 times the global average [2,27,29,43]. Fish has been a cornerstone of food security in the region because most Pacific Island countries have a low land mass: coastline ratio and limited opportunities to produce other forms of animal protein [47]. In recognition of these circumstances, the Public Health Division of the Pacific Community<sup>1</sup> has recommended that Pacific Island countries and territories should plan to provide access to at least 35 kg of fish per person per year as human populations continue to grow [43].

Until recently, much of the fish consumed in the Pacific Island region has come from coastal fisheries, which are based mainly on coral reefs [18,41,42]. However, rapid population growth is creating a gap between how much fish can be harvested sustainably from coastal fisheries and the quantity of fish recommended for good nutrition [2,3,43,45].

Three interventions, based on increasing access to the region's rich and sustainably managed tuna resources for domestic consumption, can help to fill this gap. These interventions, which acknowledge the need to keep consumption of tuna within safe levels with respect to total intake of methyl mercury [5], are: 1) assisting coastal communities to catch more tuna by fishing around nearshore, anchored fish aggregating devices (FADs) [5–7,44,46]; 2) improving the local distribution of tuna and bycatch offloaded from industrial purse-seine and longline vessels in major ports to increase the supply of fish for rapidly-growing urban and peri-urban populations [5,30,40]; and 3) maintaining/increasing

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<sup>1</sup> [www.spc.int](http://www.spc.int).

per capita consumption of canned tuna. The latter intervention promises to be of considerable significance for food security across the region because canned tuna is shelf stable – an attribute that is particularly important for inland communities in Papua New Guinea (PNG), which have poor access to fresh fish [5]. Elsewhere in the world, canned fish<sup>2</sup> products make an important contribution to average global fish consumption, which is estimated to be > 20 kg per person per year [24]. Indeed, since 2010, ~11% of total fish production from capture fisheries and aquaculture has been processed into canned products each year, with tuna comprising ~23% of all canned fish [23].

The *Regional Roadmap for Sustainable Pacific Fisheries*, endorsed by Pacific Island Leaders in 2015, embraces the need to make tuna more widely available for local food security throughout the region. The *Roadmap* specifies that an additional 40,000 t of tuna is to be made available for domestic consumption per year by 2024, relative to the quantity of locally-caught and locally-processed tuna consumed in 2014 [26]. There is particular interest in promoting consumption of fish, including tuna, to help combat the high levels of obesity and non-communicable diseases pervading the region (*Supplementary material*) due to increased consumption of imported, high-energy, nutrient-poor foods [5,13–15].

This study describes the benefits of canned fish in general, and canned tuna in particular, for improving the food security of Pacific Island people; summarises the origin and quantities of canned tuna and other canned fish sold in the region; and assesses recent national patterns of per capita canned fish consumption. It focuses on the three largest countries in the Pacific Island region – the Melanesian nations of Fiji, PNG and Solomon Islands – because that is where most people in the region live<sup>3</sup> and where most of the locally-canned tuna is produced (*Supplementary Table 1*). This study also estimates how much additional canned tuna will be needed in these three countries in 2025 and 2035 to maintain recent (2012–2014) levels of per capita consumption; assesses how much canned tuna would be needed in 2025 and 2035 under two other scenarios (a 25% and 50% increase in per capita consumption, respectively), based on differential success of efforts to promote fish in general as a nutritious alternative to high-energy, nutrient-poor foods, and/or reduced access to other supplies of fish; and identifies key actions and policies that should improve availability of locally-canned tuna to help meet prospective increases in demand.

## 2. Benefits of canned tuna

Canned tuna has similar levels of protein, minerals and several vitamins to cooked fresh reef fish, cooked fresh tuna and other canned fish (*Supplementary Tables 2 and 3*). Canned tuna is a good source of long chain omega-3 fatty acids [38], which play an important role in reducing the risk of cardiovascular disease and high blood pressure [22,34,39]. Canned tuna is also an important food for pregnant women because long chain omega-3 fatty acids are essential for infant brain development (*Supplementary material*). Potential problems associated with excessive consumption of canned tuna, and canned fish in general, are also described in the *Supplementary material*.

The shelf-stable attribute of canned tuna makes it one of the few options for increasing access to fish at inland locations without the cold chains required to deliver fresh fish. Canned tuna also provides a nutritious source of animal protein for coastal communities when sea conditions are too rough for fishing, fish are seasonally scarce, natural disasters (e.g., cyclones) damage fish habitats, or when restrictions need to be placed on catching coastal fish to support the recovery of stocks [17]. Several of these circumstances are expected to occur more frequently due to the effects of climate change [4,8].

## 3. Origin and consumption of canned fish in Melanesia

### 3.1. Methods

Import data provided by the Fiji Revenue and Customs Authority, the PNG Customs Service, and Solomon Islands Customs and Excise Division were used to estimate the average  $\pm$  standard deviation (SD) amount of canned tuna imported into each country in tonnes (t). These data were classified in accordance with the 2012 Harmonised Commodity Description and Coding System (HS) and 6-digit HS Codes, ranging from 160411 to 160420 for ‘canned fish’. Trade data were used to identify the origin of the majority of canned tuna imported into Fiji, PNG and Solomon Islands, including imports from within the region. Data based on the gross weight of canned tuna were converted to net weight of edible contents based on information provided by the Pacific Island Food Composition Tables [19] and Food Standards Australia and New Zealand,<sup>4</sup> which state that the net weight of canned tuna is ~80% of gross weight. Analyses of the origin and average available quantities of canned fish imported into the three countries were limited to the years 2012–2014 because trade data for 2015 onwards could not be obtained due to the lag time in availability of official statistics. The types of errors that can be associated with the use of trade data to assess the quantity of canned fish imported into a country are described in the *Supplementary material*.

Estimates of the average quantity  $\pm$  SD of canned tuna produced in Fiji, PNG and Solomon Islands available on domestic markets, were derived from the total weight of canned-tuna products sold locally by all fish-processing companies (canneries) in these countries from 2012 to 2014 (to match the years for which data for imported canned tuna were available). Where this information was provided as numbers of cans sold, conversions were made to the gross weight of canned product. As above, it was assumed that the net weight of locally-produced canned tuna was ~80% of the gross weight.

Average  $\pm$  SD rates of per capita consumption of canned tuna in Fiji, PNG and Solomon Islands were calculated using estimates of the total population in each country in 2012, 2013 and 2014 provided by the Statistics for Development Division at the Pacific Community.<sup>5</sup> These calculations were based on the quantities of imported and locally-produced canned tuna combined. Average  $\pm$  SD per capita consumption of all canned fish (i.e., canned tuna and other types of canned fish combined) in each country between 2012 and 2014 were estimated using the HS data for other types of canned fish imported into each country, and information from companies in Fiji and PNG producing canned mackerel from imported fresh fish. Note, however, that this information does not indicate how canned fish consumption is distributed throughout the population, i.e., the ‘accessibility’ pillar of food security [21].

To provide some information on the accessibility of canned fish, data from recent household income and expenditure surveys (HIES) were used to investigate whether there were any differences in per capita consumption of canned fish between rural and urban areas. For the three focal countries during the period 2012–2014, this was possible only for Solomon Islands based on data from the HIES conducted there in 2012/13. However, the analysis of canned fish consumption in rural and urban areas was also extended to seven other Pacific Island countries and territories (Federated States of Micronesia, Nauru, Palau, Tokelau, Tonga, Vanuatu and Samoa) using data from national HIES conducted between 2010 and 2016. This analysis provided a broader picture of canned fish consumption across much of the region.

<sup>2</sup> Fish is defined in the broad sense to include finfish and invertebrates.

<sup>3</sup> [www.sdd.spc.int](http://www.sdd.spc.int).

<sup>4</sup> <http://www.foodstandards.gov.au/science/monitoringnutrients/ausnut/ausnutdatafiles/Pages/fooddetails.aspx>.

<sup>5</sup> <https://sdd.spc.int/en/>.

**Table 1**

The origin and quantity in tonnes (t) of canned tuna and other canned fish available in Fiji, Papua New Guinea and Solomon Islands between 2012 and 2014. Estimated per capita consumption of all canned fish, and canned tuna, is also shown for each country. Net weights represent contents of cans.

Feature of canned fish production and consumption	Country								
	Fiji			Papua New Guinea			Solomon Islands		
	2012	2013	2014	2012	2013	2014	2012	2013	2014
Weight of tuna processed for domestic sale (in t) <sup>a</sup>	5330 <sup>a</sup>	6870 <sup>a</sup>	7462 <sup>a</sup>	6533	8780	9205	7022 <sup>a</sup>	8018 <sup>a</sup>	7495 <sup>a</sup>
Imports of canned tuna (net weight in t) <sup>b</sup>	2159	710	1081	5476	3651	6215	185	539	239
Canned tuna produced and sold domestically (net weight in t)	2132 <sup>c</sup>	2748 <sup>c</sup>	2985 <sup>c</sup>	2613 <sup>d</sup>	3512 <sup>d</sup>	3682 <sup>d</sup>	2809 <sup>c</sup>	3207 <sup>c</sup>	2998 <sup>c</sup>
Total canned tuna available (net weight in t)	4291	3458	4066	8089	7163	9897	2994	3746	3237
Percentage of canned tuna derived from local canneries	50	79	73	32	49	37	94	86	93
Other canned fish produced domestically (net weight in t) <sup>e</sup>	1796	1638	1756	4000 <sup>h</sup>	4000 <sup>h</sup>	4000 <sup>h</sup>	0	0	0
Imports of other canned fish (net weight in t) <sup>f</sup>	2358	1185	2058	854	1884	1455	267	265	267
Total canned fish available (net weight in t)	8446	6281	7879	12,943	13,047	15,352	3261	4011	3504
Estimated human population of country <sup>g</sup>	855,500	859,200	863,100	7,227,600	7,398,500	7,774,900	582,000	610,800	626,400
Per capita consumption of all canned fish (kg person <sup>-1</sup> yr <sup>-1</sup> )	9.9	7.3	9.1	1.8	1.8	2.0	5.6	6.6	5.6
Per capita consumption of canned tuna (kg person <sup>-1</sup> yr <sup>-1</sup> )	5.0	4.0	4.7	1.1	1.0	1.3	5.1	6.1	5.2
Percentage of canned fish consumed comprised of tuna	51	55	52	62	55	64	92	93	92

<sup>a</sup> = derived from net weight of canned tuna sold locally divided by 0.4 because the packed weight of fish in a can averages 40% of whole weight of processed fish.

<sup>b</sup> = calculated as 80% of gross weight of imported canned tuna given in [Supplementary Table 4](#).

<sup>c</sup> = calculated as 80% of gross weight of canned tuna.

<sup>d</sup> = calculated as 40% of whole weight of fish processed for canning.

<sup>e</sup> = mackerel, calculated as 80% of gross weight of canned product.

<sup>f</sup> = mainly mackerel, sardines and pilchards, calculated as 80% of gross weight of canned product.

<sup>g</sup> = source: Statistics for Development Division, Pacific Community; 2012 values are midpoint between 2011 and 2013.

<sup>h</sup> = based on information from the company canning mackerel in PNG producing 15,000 t between 2012 and 2014, calculated as 80% of gross weight.

### 3.2. Imports of canned fish

Imports of canned tuna and other canned fish were significant between 2012 and 2014, particularly in PNG ([Table 1](#)), where an average of  $5114 \pm 1320$  t of canned tuna and  $1398 \pm 517$  t of other canned fish products were imported each year. The annual average net weight of canned tuna imported into Fiji was  $1317 \pm 753$  t and the average quantity of other canned fish products was  $1867 \pm 609$  t. The figures for Solomon Islands were considerably lower – average annual imports of tuna and other canned fish products were  $321 \pm 191$  and  $266 \pm 1$  t, respectively. Based on the data available, it was not possible to determine the reasons for the variation in the quantity of imports to a given country from year to year ([Table 1](#)).

### 3.3. Origin of imported canned fish

Much of the canned fish imported into the region between 2012 and 2014 came from Southeast Asia. In Fiji, most imported canned tuna came from Thailand and Indonesia, whereas most of the other canned fish came from China ([Supplementary Table 4](#)). In PNG, the majority of canned tuna imported in 2012 came from the Philippines, Indonesia and to a lesser extent Thailand, whereas in 2013 and 2014 the majority came from Thailand ([Supplementary Table 4](#)). Most of the other canned fish imported into PNG originated from Thailand and China. In Solomon Islands, the relatively small quantities of canned tuna imported from Southeast Asia came mainly from Thailand, whereas the majority of the other imported canned fish originated from the Philippines ([Supplementary Table 4](#)).

Imports of canned tuna from other Pacific Island countries were relatively important in Fiji, where an average of  $37\% \pm 13\%$  of total imports each year came from either PNG or Solomon Islands ([Supplementary Table 4](#)). In contrast, an average of only  $3\% \pm 2\%$  of all canned tuna imported into PNG each year came from Fiji and Solomon Islands. In Solomon Islands, an annual average of  $15\% \pm 7\%$  of the relatively small quantities of imported canned tuna came from PNG and Fiji ([Supplementary Table 4](#)).

The patterns and quantities of imports summarised here need to be interpreted with caution. Although supporting data could not be

obtained due to the lag time in availability of official statistics, observations suggest that imports of canned tuna may have increased since 2014 due to canneries in China and elsewhere in Southeast Asia seeking a greater share of the market and competing directly with popular local products and brands. Indeed, it is now easy to find canned tuna imports in the region labelled to look like local Pacific Island products. The aggressive marketing of these imports is pitched at a unique segment of the market for canned tuna in the Pacific Island region – the use of lower-cost, dark-meat canned tuna for flavouring staples such as cassava and rice ([Supplementary material](#)). For example, dark-meat tuna, so-called ‘blue’ canned-tuna products (named after the popular ‘Solomon Blue’ described below) are now common on local markets.

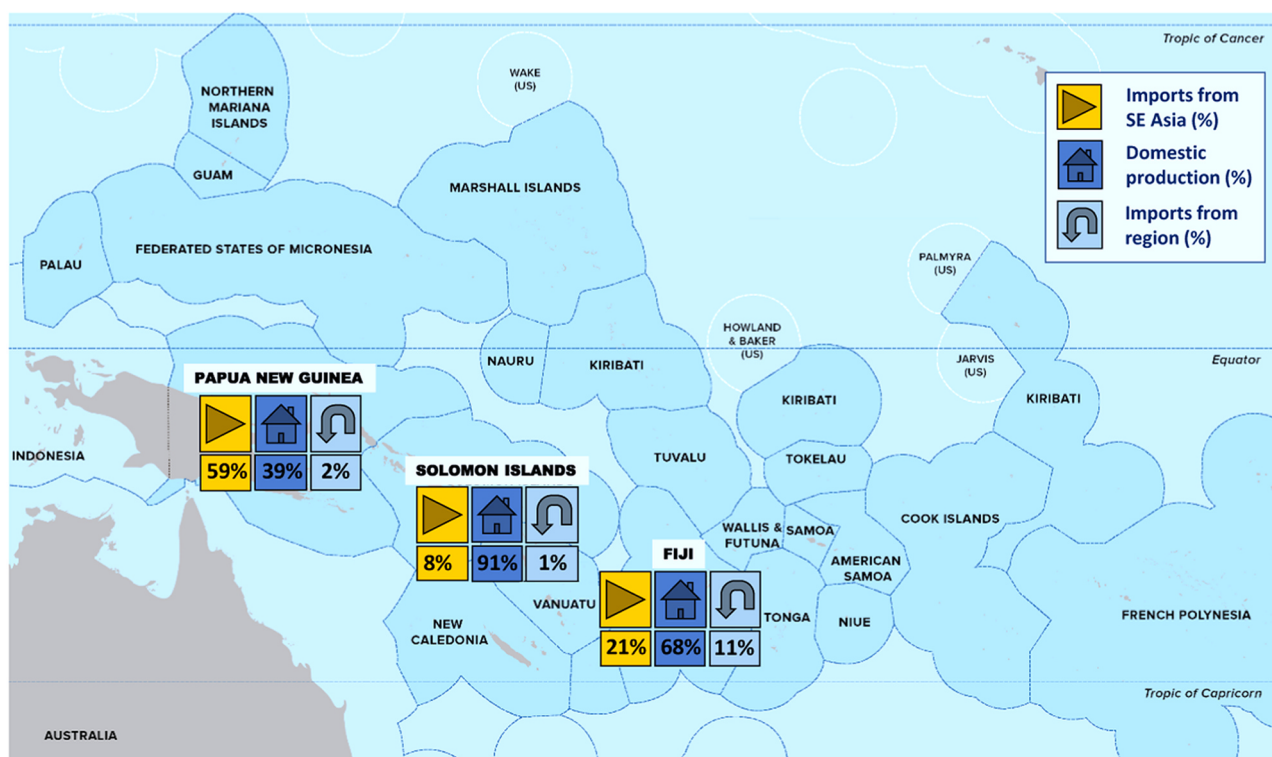
### 3.4. Sales of locally-canned fish

The average net weight of canned tuna produced in national canneries and sold on the domestic market each year was  $3269 \pm 574$  t in PNG,  $2622 \pm 440$  t in Fiji and  $3005 \pm 199$  t in Solomon Islands ([Table 1](#)). The average annual net weight of canned mackerel produced in the region and sold on domestic markets was estimated to be  $\sim 4000$  t per year in PNG, and  $1730 \pm 82$  t in Fiji ([Table 1](#)).

### 3.5. Relative importance of canned tuna from different origins

There were substantial differences in the sources of canned tuna among the three countries ([Fig. 1](#)). Solomon Islands was largely self-sufficient, with an average of  $91\% \pm 4\%$  of all canned tuna sold between 2012 and 2014 coming from the local cannery. The annual average market share of locally-canned tuna was also relatively high ( $68\% \pm 16\%$ ) in Fiji. In contrast, PNG relied heavily on imported canned tuna, with an average of  $59\% \pm 10\%$  of all canned tuna sold in the country each year originating from Southeast Asia ([Fig. 1](#)).

The more limited size of the domestic market and ready access to fish for canning appear to partially explain the high sales of locally-canned tuna in Solomon Islands. However, good marketing has also played a role. The national cannery's signature ‘Solomon Blue’ product was the only dark-meat tuna available locally when introduced, and its



**Fig. 1.** The average percentage of canned tuna imported mainly from Southeast Asia, produced domestically, or imported from neighbouring Melanesian countries (the region) into Fiji, Papua New Guinea and Solomon Islands between 2012 and 2014. Further details of the origin of canned tuna imported from Southeast Asia are given in [Supplementary Table 4](#).

price remains competitive even in the face of the look-alike imports mentioned above.

The high dependence of PNG on imported canned tuna can be explained partly by failure of the existing canneries to operate at full capacity and the fact that the fish-processing companies operating there have not made the local market a high priority. The need for significant imports of canned tuna in Fiji can be attributed largely to limited access to fish for processing locally and the relatively large domestic market. In both PNG and Fiji, locally-canned tuna faces stiff competition from imports due to lower costs of production in Southeast Asia and progressive reduction of tariffs on imported canned fish, particularly in PNG ([Supplementary material](#)). However, it is not clear why imports from the region accounted for 11% of all canned tuna consumed in Fiji but only 2% in PNG ([Fig. 1](#)).

### 3.6. Consumption of canned fish

When all sources of canned fish were combined, the greatest quantities per year were consumed in PNG, e.g., > 15,000 t in 2014, followed by Fiji and Solomon Islands ([Table 1](#)). This is not surprising, given the differences in population size between the countries. However, there were large differences in per capita consumption of canned fish ([Table 1](#)). Average annual national consumption of all canned fish per person was considerably greater in Fiji ( $8.8 \pm 1.3$  kg) and Solomon Islands ( $5.9 \pm 0.6$  kg) than in PNG ( $1.9 \pm 0.1$  kg). Canned tuna comprised an average of  $53\% \pm 2\%$  of the canned fish consumption in Fiji,  $60\% \pm 5\%$  in PNG, and  $92 \pm 1\%$  in Solomon Islands ([Table 1](#)).

Consumption of all canned fish combined indicates that it is making a significant contribution to average national fish consumption in all countries. In Fiji, where average national fish consumption is 21 kg per person per year [2], canned fish in general accounts for an average of  $42 \pm 6\%$  of total fish consumption, and canned tuna provides an average of  $22 \pm 2\%$  of all fish consumed. Based on the average national fish consumption of 33 kg per person per year in Solomon Islands

[2], canned fish contributes an average of  $18 \pm 2\%$ , and canned tuna contributes an average of  $17 \pm 2\%$ , of all fish consumption. In PNG, average national per capita fish consumption is estimated to be only 13 kg per person per year [2] because > 60% of the population lives inland, where access to fish is difficult due to poorly developed supply chains. Canned fish in general, and canned tuna in particular, are estimated to comprise an average of  $14 \pm 1\%$  and  $9 \pm 1\%$  of national fish consumption in PNG, respectively.

When consumption of canned fish is assessed relative to the recommended quantity of fish for good nutrition for Pacific Island people, i.e., 35 kg per person per year [43], it provides an average of  $25 \pm 4\%$  of this target in Fiji, and  $17 \pm 2\%$  in Solomon Islands. Canned tuna alone is providing an average of  $13 \pm 1\%$  of recommended annual per capita fish consumption in Fiji and  $16 \pm 2\%$  in Solomon Islands. The recommended consumption of 35 kg of fish per person per year cannot be applied to PNG for the reasons outlined above [2,5]. However, any increase in the contribution of canned products to per capita fish consumption in inland areas of PNG will depend largely on improving physical access to canned fish ([Section 4](#)), and increasing purchasing power.

### 3.7. Consumption based on household income and expenditure surveys (HIES)

The results from the latest HIES in Solomon Islands showed that urban communities consumed more than twice as much canned fish as rural communities ([Table 2](#)). There was considerable variation in canned fish consumption among and within many of the other seven Pacific Island countries and territories for which recent HIES data were available ([Table 2](#)). Average national consumption of canned fish in Samoa (9.3 kg per person per year) was higher than our estimates for Fiji based on production data (8.8 kg), and national consumption of canned fish in Tokelau (6.4 kg) was higher than our estimate for Solomon Islands (5.9 kg). The difference in consumption of canned fish in



**Table 2**

Estimates of national, rural and urban consumption of canned fish (kg/person/year, net weight) for Solomon Islands and seven other Pacific Island countries and territories derived from household income and expenditure surveys (HIES) conducted between 2010 and 2016.

Country/Territory	National	Rural	Urban	Year
Federated States of Micronesia	3.90	4.69	2.83	2013/14
Nauru <sup>a</sup>	1.93			2012/13
Palau	5.50	6.14	5.36	2014
Samoa	9.32	9.53	8.45	2013
Solomon Islands	4.93	3.37	8.86	2012/13
Tokelau <sup>a</sup>	6.45			2015/16
Tonga	2.96	3.10	2.48	2015/16
Vanuatu	5.14	4.86	5.95	2010

<sup>a</sup> = breakdown into rural and urban consumption not possible due to the small size of the country/territory.

rural and urban areas was not as pronounced in the other seven countries and territories as it was in Solomon Islands, and the trend was often in the opposite direction with higher consumption occurring in rural areas in most cases (Table 2).

#### 4. The challenge of maintaining per capita consumption of canned tuna

The global food trade, which has increased the availability of high-energy, low-nutrient imported foods in the region [13,15], poses a significant risk to the vital role that canned tuna and other types of fish play in local food security [14]. Concerted efforts will be needed to maintain/increase per capita consumption of canned tuna in Fiji and Solomon Islands, and augment the modest consumption in inland PNG, as availability of poor-quality, imported food increases and populations continue to grow. Two key actions that Pacific Island governments can take to ensure canned tuna continues to make an important contribution to national and maternal nutritional security to help stem the tide of deteriorating public health (Supplementary Table 5) are described below.

##### 4.1. Promote consumption of fish to help combat the regional 'nutrition double burden'<sup>6</sup>

Campaigns are needed to increase awareness of the health benefits of eating fish, including canned tuna, and the role that fish can play in reducing the prevalence of non-communicable diseases in adults and malnutrition among children. Such campaigns will be facilitated by 1) targeted advertising that highlights the health benefits of fish and distinguishes canned tuna from other processed foods; 2) imposition of higher taxes on unhealthy imported foods [12,25], as proposed under the *Pacific Islands Non-Communicable Diseases Roadmap*<sup>7</sup>; and 3) an end-to-end supply chain analysis of the factors (e.g., origin, access, taste and price) influencing purchases of fish and canned-fish products to identify and reduce obstacles to consumption of fish in preference to less-nutritious foods. Raising awareness that canned tuna can be a substitute for fresh fish when catches are affected by storms, natural disasters and the other factors mentioned in Section 2, should also assist people to maintain a healthy diet.

##### 4.2. Improve distribution of canned tuna to the population of inland PNG

Increasing access to canned tuna in inland PNG is an important need because more people live there than in all other Pacific Island countries

and territories combined,<sup>8</sup> and animal protein is often scarce in the diet [9]. Key actions for increasing the availability of canned tuna in inland PNG include surveys to assess the nature and size of the market; tailoring canned-tuna products to meet market demand; and upgrading distribution networks to deliver these products to inland areas. The Government of PNG could consider subsidising the cost of distributing locally-canned tuna and other nutritious food to the large inland population by using some of the substantial funds gained from recent increases in revenue from industrial tuna fishing access fees [31,32]. Allocation of a portion of this revenue for such purposes would help transfer the benefits of the nation's rich tuna resources to more of its citizens.

#### 5. Planning to meet future demand for canned tuna

Estimates of how much canned tuna may be needed in Fiji, PNG and Solomon Islands by 2025 and 2035 if the actions described above are more or less successful were made based on three scenarios: 1) continued appreciation of canned tuna and availability of other sources of fish, resulting in maintenance of the average rates of per capita canned tuna consumption described here; 2) modest success of campaigns to promote canned tuna as a healthier alternative to other processed foods in the fight against non-communicable diseases, combined with some difficulties in obtaining other types of fish, resulting in a 25% increase in consumption of canned tuna per capita; and 3) greater success of campaigns to promote canned tuna, combined with more substantial difficulties in obtaining other types of fish, resulting in a 50% increase in consumption. Calculations were made for both locally-canned and imported canned tuna and were based on the assumption that the proportions of locally-canned and imported canned tuna consumed remain the same over time.

The additional quantities of canned tuna needed by 2025, relative to 2012–2014, vary considerably among the three countries (Fig. 2a). This variation is due to the interplay between present national population size, existing rates of per capita consumption of canned tuna, and the rate of population growth (Tables 1 and 3).

When the focus is placed on the additional quantities of locally-canned tuna required, for the reasons explained in Section 6, only a small (6%) increase in production would be needed to maintain per capita consumption in Fiji by 2025 under Scenario 1 (Table 4) due to the low rate of population growth (Table 3). However, a 59% increase in production of locally-canned tuna (1538 t) would be needed in Fiji by 2025 under Scenario 3 (Table 4). Although the population in PNG is predicted to increase by more than two million people by 2025 relative to 2012–2014 (Table 3), the low per capita consumption of locally-canned tuna means that only a 33% increase in production (1063 t) would be needed under Scenario 1 by 2025, increasing to 99% (3230 t) under Scenario 3 (Table 4). In Solomon Islands, the country with the lowest population, relatively rapid population growth (Table 3) will create the need for a 32% (969 t) increase in production of locally-canned tuna under Scenario 1 and a 98% (2956 t) increase under Scenario 3 by 2025 (Table 4).

The projected increases in locally-canned tuna needed by 2035 under the three scenarios followed similar patterns, however, the volumes of canned tuna required under each scenario are greater (Fig. 2b) due to predicted population growth. For example, under Scenario 3, a 131% increase (4285 t) in locally-canned tuna would be required in PNG, and a 151% (4546 t) increase would be needed in Solomon Islands (Table 4).

<sup>8</sup> In 2013, about 4,440,000 people were estimated to live more than 5 km from a river or the coast in PNG, whereas the combined population of all other Pacific Island countries and territories was 3,168,000 (source: Statistics for Development Division, Pacific Community).

<sup>6</sup> <http://www.policyforum.net/the-pacifics-double-burden-of-disease/>.

<sup>7</sup> <http://www.worldbank.org/en/news/feature/2014/07/11/pacific-islands-non-communicable-disease-roadmap>.

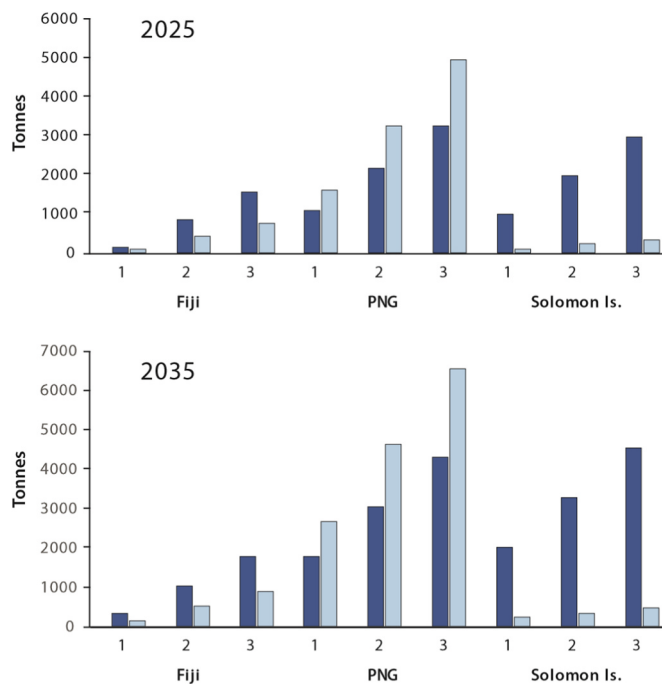


Fig. 2. Additional quantities (tonnes, net weight) of locally-canned tuna (dark blue) and imported canned tuna (light blue) needed by 2025 and 2035 under the three scenarios (see text) in Fiji, Papua New Guinea (PNG) and Solomon Islands.

## 6. Actions needed to increase production of locally-canned tuna

The quantities of locally-canned tuna needed to maintain per capita consumption, or to capitalise on Scenarios 2 and 3 (Table 4), are based on the assumption that the existing market share of locally-canned tuna in Fiji, PNG and Solomon Islands will be maintained. This is by no means certain, given the strong competition from imports. There are, however, a number of actions (in addition to those described in Section 4) that the three countries could take to maintain (or increase) their share of future domestic markets for canned tuna. These actions centre around 1) increasing the competitiveness of tuna processed in the region; 2) ensuring that local canneries have sufficient supplies of tuna to meet demand and achieve economies of scale; and 3) improving access to locally-canned tuna.

A strong incentive for implementing these measures is that increased employment in the fish-processing sector also provides another (indirect) way for canned tuna to contribute to local food security – the additional jobs in canneries needed to increase production should provide more households with income to purchase food, thus improving the ‘access’ pillar of food security [21]. The role of domestic canned-tuna production in contributing to food security could be enhanced further if national canneries also succeeded in replacing some of the imported canned tuna. Reducing the dependence on imported canned tuna would also have the advantage of lowering exposure to variation in external market forces that may affect the supply of products from overseas [16].

Tariffs applied at different stages of the value chain can influence the direction and volume of trade [10]. For example, relatively low tariffs on tuna loins could provide incentives for investment in canning operations or improve supply into existing canneries in the region. However, tariffs are just one of many factors – alongside labour efficiency, transportation costs and input costs – influencing investment decisions in island states [11,33]. Understanding the impacts of any specific policy would require research and detailed analysis of opportunities and challenges associated with using trade and investment policies to expand local production and availability of canned tuna in

Pacific Island countries.

Such analysis is beyond the scope of this paper. However, as a starting point, efforts to maintain the market share of locally-canned tuna may be complemented by exploring whether the Melanesian Spearhead Group Trade Agreement<sup>9</sup> and the Pacific Island Country Regional Trade Agreement<sup>10</sup> could enable canneries in Pacific Island countries to compete more effectively with companies from Southeast Asia. In particular, it will be important to explore whether these agreements could support increased production and intraregional trade of canned tuna, enabling canneries in Fiji, PNG and Solomon Islands to gain a greater share of imported tuna sales in each other's domestic markets. The greatest potential to increase intraregional trade of canned fish is in PNG, where only 2% of imported tuna came from Fiji or Solomon Islands between 2012 and 2014 (Fig. 1). The Parties to the Pacific Agreement on Closer Economic Relations (PACER) Plus<sup>11</sup> also have some rights to protect infant industries<sup>12</sup> or give accelerated preferential access to other Parties [20]. However, the absence of PNG and Fiji from PACER Plus for the foreseeable future [20] considerably reduces the potential of this vehicle to boost intraregional trade in processed fish. PACER Plus also has limited scope for assisting the Pacific Island countries that have signed the agreement, other than perhaps Solomon Islands, with fish processing/trade because they are unlikely to have the potential economies of scale and competitive cost structures to support successful export industries for processed fish [48].

## 7. Policy implications

Suggested policies to support the actions described in Section 6 are summarised in Table 5. Some of these suggestions are already being implemented. For example, in 2018, the Government of PNG will provide licensing rebates for foreign fleets offloading fish for processing locally [37], and the Parties to the Nauru Agreement Office<sup>13</sup> has assisted the Marshall Islands to establish a micro-cannery to process fish for local consumption. Although this small-scale cannery faces economic challenges not encountered by efficient industrial canneries, and the cost of importing empty cans is high, it benefits from a supply of free fish from transshipping operations in Majuro lagoon. These fish are tuna that are too small to sell to other processors, or non-tuna bycatch that would otherwise be discarded.

Although the actions summarised in Table 5 have much potential to assist canneries in Fiji, PNG and Solomon Islands to maintain/increase their share of the domestic markets for canned tuna, they are exposed to some risks. Examples of these risks include 1) the effects of demand for dark-meat tuna from the pet-food trade on incentives to use dark-meat tuna for local consumption; 2) the influence of strong El Niño and La Niña episodes on the locations where tuna are caught [35,36] and the consequent impacts on minimum deliveries of tuna to enable canneries to achieve economies of scale; and 3) a general lack of experience in canning fish, including stringent oversight of the necessary heat

<sup>9</sup> Trade Agreement among the Melanesian Spearhead Group Countries. Agreed on 27 October 2005 in Port Moresby. Available at <http://www.msgsec.info/index.php/publicationsdocuments-a-downloads/msg-trade-agreement-2005>. Accessed on 6 December 2017.

<sup>10</sup> Pacific Island Countries Trade Agreement (PICTA). Agreed on 18 August 2001 at Nauru. <http://www.forumsec.org/resources/uploads/attachments/documents/PICTA.pdf>. Accessed on 6 December 2017.

<sup>11</sup> Pacific Agreement on Closer Economic Relations Plus (PACER Plus). Signed by Australia, Cook Islands, Kiribati, New Zealand, Nauru, Niue, Samoa, Solomon Islands, Tonga and Tuvalu 14 June 2017 in Nuku'alofa, and by Vanuatu on 7 September 2017 in Apia. Available at <http://dfat.gov.au/trade/agreements/pacer/Pages/pacific-agreement-on-closer-economic-relations-pacer-plus.aspx>. Accessed on 6 December 2017.

<sup>12</sup> PACER Plus Article 9.

<sup>13</sup> [www.pnatuna.com/](http://www.pnatuna.com/).

**Table 3**

Predicted population growth in Fiji, Papua New Guinea (PNG) and Solomon Islands by 2025 and 2035, together with projected quantities of locally-canned and imported canned tuna needed in tonnes (t) to maintain per capita consumption of canned tuna (relative to the average for the period 2012–2014) (Scenario 1) in 2025 and 2035. Numbers in brackets indicate the increased production of canned tuna required in tonnes, relative to 2012–2014. Calculations are based on the assumption that the proportions of locally-canned and imported canned tuna consumed remain the same over time.

Country	Average population (2012–2014)	Predicted population <sup>a</sup>		Origin of canned tuna	Average net weight (t) of canned tuna sold (2012–2014)	Average per capita consumption (kg.pers <sup>-1</sup> .year <sup>-1</sup> ) (2012–2014)	Total canned tuna needed (t) [additional tuna needed (t)]	
		2025	2035				2025	2035
Fiji	859,250	909,300	962,600	Local	2622	3.05	2773 (151)	2936 (314)
				Imported	1317	1.53	1391 (74)	1473 (156)
PNG	7,467,000	9,846,300	11,446,000	Local	3269	0.44	4332 (1063)	5036 (1767)
				Imported	5114	0.68	6695 (1581)	7783 (2669)
Solomon Islands	606,400	802,800	1,017,000	Local	3005	4.95	3974 (969)	5034 (2029)
				Imported	321	0.53	425 (104)	539 (218)

<sup>a</sup> Source: Statistics for Development Division, Pacific Community.

**Table 4**

Additional quantities in tonnes (t) of locally-canned tuna needed by 2025 and 2035 in Fiji, Papua New Guinea (PNG) and Solomon Islands under the three proposed scenarios relative to average quantities sold on the domestic market for the period 2012–2014 (see Table 3). Numbers in brackets indicate the percentage increase in locally-canned tuna required. Calculations are based on the assumption that the proportions of locally-canned and imported canned tuna consumed remain the same over time.

Country	2025			2035		
	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
Fiji	151	845	1538	314	1049	1783
	(6%)	(32%)	(59%)	(12%)	(40%)	(68%)
PNG	1063	2146	3230	1767	3026	4285
	(33%)	(66%)	(99%)	(54%)	(93%)	(131%)
Solomon Islands	969	1962	2956	2029	3288	4546
	(32%)	(65%)	(98%)	(67%)	(109%)	(151%)

treatment of fish placed in cans to avoid the risk of histamine poisoning [1] and botulism, in some of the smaller Pacific Island countries that may wish to consider micro-canneries.

It is also possible that increased sales of canned tuna by local canneries on domestic markets may not result in more jobs if there is a substantial decline in sales to export markets. In this regard, it is particularly important for PNG to maintain preferential access to the European market, including under its Interim Economic Partnership Agreement with the European Union. Solomon Islands could also accede to this agreement (which has global sourcing provisions) to broaden options for the supply of raw materials for local processing, and in case its status as a Least Developed Country (which provides tariff preferences) is revised. The suggested supporting policies listed in Table 5 should be tailored to minimise these risks.

To measure the potential and outcomes of the recommended actions and supporting policies, better access will be needed to data on 1) the amount of locally-canned tuna sold on domestic markets, and 2) the quantities, quality and origin of imported canned tuna. Recent improvements to HIES, which partition fish consumption into a wider range of fish types, including canned tuna, will help to provide this information. However, the typical 5-year cycle of HIES means that timely access to data on canned tuna imports, and to domestic sales of locally-canned tuna, will be the best source of information in most years.

Our analysis also provides part of the information required to establish the baseline for the tuna food security goal of the *Regional Roadmap for Sustainable Pacific Fisheries* so that the associated annual *Report Card*<sup>14</sup> can be completed. To determine whether an additional 40,000 t of tuna has been made available for local nutrition each year by 2024, Pacific Island fisheries managers need to know how much

locally-caught tuna was used for domestic consumption before the *Roadmap* was released in 2015. Our study shows that in 2014, a total of ~24,000 t of whole tuna was processed in Fiji, PNG and Solomon Islands to produce canned tuna for local markets (Table 1). In addition, a loose estimate indicates that another 24,000 t of tuna is likely to have been caught per year in the region by small-scale commercial fishers [28]. To establish the baseline, the quantity of locally-canned tuna needs to be added to revised estimates of the small-scale commercial tuna catch, the amounts of tuna caught by subsistence fishers (derived from HIES), and the quantity of tuna offloaded at regional ports during transshipping operations for local consumption.

## 8. Conclusions

Canned tuna processed in the Pacific Island region makes a substantial contribution to the recommended consumption of 35 kg of fish per person per year for people in Fiji (13%) and Solomon Islands (16%). Canned tuna is particularly beneficial because it provides a non-perishable source of nutritious food for communities at times when, and in places where, other supplies of fish are low. A key challenge for Fiji and Solomon Islands will be to maintain, and preferably increase, the per capita consumption of locally-canned tuna as their populations grow. The key challenge for PNG, where canned fish in general contributes an average of only ~2 kg of fish per person per year nationwide, will be to find ways to distribute locally-canned tuna to inland areas to improve the nutrition of the large population living there.

Addressing these challenges by implementing the actions and supporting policies summarised in Table 5 will assist Fiji, PNG and Solomon Islands to harness the direct and indirect benefits of canned tuna for nutrition of coastal, urban and inland communities. It will also assist national governments to achieve the food security goal of the *Regional Roadmap for Sustainable Pacific Fisheries*.

<sup>14</sup> [http://www.ffa.int/system/files/Tuna\\_Card\\_web\\_0.pdf](http://www.ffa.int/system/files/Tuna_Card_web_0.pdf).

**Table 5**

Suggested policies to support the aims of actions implemented to maintain (or increase) the market share of locally-canned tuna in Fiji, Papua New Guinea and Solomon Islands.

Aim of action
Suggested supporting policies for governments and/or regional agencies
<p>Increase the competitiveness of locally-canned tuna</p> <ul style="list-style-type: none"> <li>Specify minimum quality and nutritional standards for both locally-produced and imported canned tuna</li> <li>Explore the extent to which national and regional economic and trade policies can facilitate import of materials (e.g., cans) needed by local fish-processing companies</li> <li>Develop incentives for companies allocating more dark-meat tuna products for human consumption</li> <li>Improve efficiency of state-owned enterprises providing services for fish processing (water, electricity and port services)</li> <li>Link concessions for access fees to actual processing volumes, or develop other financial mechanisms to support processing</li> <li>Provide training for workers to improve efficiency and reduce absenteeism</li> <li>Expand the fish-processing sector to provide economies of scale</li> </ul> <p>Ensure local canneries have sufficient supplies of tuna to meet demand and achieve economies of scale</p> <ul style="list-style-type: none"> <li>Mandate minimum deliveries of tuna to local canneries using licence offloading requirements, or rebates/incentives</li> <li>Arrange tax concessions for companies landing and processing tuna</li> <li>Provide incentives for purse-seine vessels to tranship catches in Fiji</li> </ul> <p>Improve access to locally-canned tuna</p> <ul style="list-style-type: none"> <li>Promote the health benefits of canned tuna to raise awareness of the advantages and availability of the products</li> <li>Provide tax incentives for companies allocating more tuna for sale on the local market</li> <li>Link fishing access arrangements for vertically-integrated companies operating canneries to minimum domestic sales levels at affordable prices</li> <li>Support micro-canneries in smaller Pacific Island countries where access to low-cost fish, e.g. bycatch from industrial fishing fleets, would make such enterprises profitable; consider prohibiting the discarding of non-tuna bycatch species to increase the supply of fish for processing operations</li> <li>Allocate tuna licence revenue to supporting infrastructure for domestic production and supply chains to inland areas</li> </ul>

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## Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.marpol.2018.10.034.

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