



# Seventh SPC Regional Technical Meeting on Coastal Fisheries and Aquaculture

19–22 November 2024



Original: English

Information paper 13 (external paper)

## A proposed pragmatic statistical framework for national small-scale fisheries based on available information and tools in the Pacific: an application to Solomon Islands

Raymond Lae<sup>1</sup>, Luis Tito De Morais <sup>1</sup>, Xavier Vincent<sup>2</sup>, Ivory Masiala Akao<sup>3</sup>, Pablo Chavance<sup>1</sup>, Anita Kendrick<sup>1</sup>

---

<sup>1</sup> Consultant for the World Bank

<sup>2</sup> WorldBank – Lead Fisheries Specialist ([xvincent@worldbank.org](mailto:xvincent@worldbank.org))

<sup>3</sup> SPC FAME Community-Based Fisheries Management Officer

# A proposed pragmatic statistical framework for national small-scale fisheries based on available information and tools in the Pacific: an application to Solomon Islands

## *Summary*

- Small-scale fisheries are challenging to monitor and, therefore, difficult for the national authorities to quantify. The inability of the Pacific Island countries and territories (PICTs) to have a consolidated view that incorporates both socio-economic and biological data on a national scale is widely recognised.
- A wealth of secondary data exists in the region from household surveys carried out regularly by national governments for decades, covering a wide range of subjects. These national surveys generally include questions that provide direct or indirect information on households' activities and sources of income. Where they occur, fishing activities could be captured, as well as their contribution to the household's food supply, incomes, and expenses.
- For Solomon Islands, the authors used data from the 2019 general population census to identify and categorise fishing households by their fishing practices and other characteristics, and their distribution across the country according to the various administrative units and boundaries.
- These analyses of the national census data provide a statistical framework that can be used to robustly extrapolate at the national level the data monitored from a representative sample of fishing households. Pragmatic geographical stratification can be done based on the importance of the strata (in terms of number of fishing households, main activities, representation of diverse groups, and the distance and accessibility of the area).
- The aim is to maximise utility by collecting as little new data as possible and drawing more conclusions or lessons from the information already available and well as existing tools.
- This paper proposes a practical statistical framework for monitoring small-scale fisheries in PICTs that the World Bank could help further to support, upon country request.

## *Context of small-scale fishing*

1. Small-scale fisheries in PICTs play an essential role in the daily supply of protein and minerals to the inhabitants, and thus in food security and rural development. (SPC 2015, Si-MFMR 2019, Ayilu et al. 2022). These activities play a significant social and cultural role in many Pacific communities and are also an important source of resilience. Fisheries can act as a safety net during crisis and scarcity by providing subsistence provisioning and alternative sources of income.
2. This generic terminology conceals a wide range of small-scale fishing practices carried out by both men and women, with or without boats. These practices are mainly for subsistence purposes and are carried out in all coastal or inland geographical zones where communities settle.
3. These geographically dispersed and mainly small-scale activities are challenging to monitor and, therefore, difficult for the national authorities to quantify. There are precise observations on limited geographical areas or time scales within the framework of specific projects, but the inability of the Pacific Island countries to have a consolidated view that incorporates both socio-economic and biological data on a national scale is widely recognised in the literature (Gillett and Tauati 2018; Gillett and Fong 2023).

4. Effective fisheries management is necessary in PICTs to ensure food independence, employment and the sustainability of coastal resources to support rural populations. This must be based on a sound knowledge of the small-scale fisheries, but monitoring is challenging and costly to implement. Key parameters to be monitored in small-scale fisheries to inform decision-making and measure policy impacts on environmental, social, and economic sustainability of the fisheries should include at least catch quantities, fishing effort, species composition, biological parameters (size, maturity, etc.), job generation, revenue, and costs. Analyses must be able to be broken down by geographical areas, time periods, fishing practices, and gender. A simplified approach to collecting data for monitoring is needed.
5. This paper proposes a practical statistical framework for monitoring small-scale fisheries in Pacific Island countries. The World Bank is willing to support, upon country request, fostering an effective information management system (IMS) for fisheries management and development. For this purpose, financial resources could be mobilised under the Pacific Islands Regional Oceanscape Program (PROP) implemented by some Pacific Community's (SPC) member countries and the Forum Fisheries Agency, and possibly SPC in the near future. The World Bank Global Program for the Blue Economy (PROBLUE) has supported the initial work that has informed this paper and could help further support at country demand.

### *Available information in Pacific Island countries*

6. A notable aspect of the region is the wealth of surveys carried out regularly by national governments for decades, covering a wide range of subjects from the classic population census to the monitoring of agricultural activities and the assessment of income, expenditures, and food self-consumption. The role of SPC's Statistics for Development Division (SDD) is notably to coordinate and support the development, production, and delivery of official statistics for Pacific Island Countries and Territories (PICTs). The table below synthesises the surveys carried out in the PICTs between 2012 and 2023.

*Table 1: Summary of surveys carried out by PICTs between 2012 and 2023.*

PICTs	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
American Samoa							Busin	Agric	PHC			
Cook Islands				HIES	PHC			LFS		PHC, Agric, Covid		LFS
Federated States of Micronesia		HIES			Agric				HIES	M-DH	PHC	HIES, LFS
Fiji (Republic of)		HIES				PHC		HIES	Agri	MICS		
French Polynesia	PHC			HIES		PHC	LFS	LFS	LFS	LFS	PHC, LFS	LFS
Guam	Agric					Agric	Agric	HIES	PHC			
Mariana Islands (CNMI)	Agric				HIES	Agric, LFS		LFS, Agric	PHC	HIES, LFS		LFS Agric
Marshall Islands (Republic of)	LFS							HIES	Covid	PHC, M-DH	HHL	
Pitcairn Islands				PHC								
Solomon Islands	HIES			DHS		Agric		PHC				HIES
Kiribati				PHC			HHL, MICS, DHS	HIES	PHC, HHL	Disab, LFS	Agric	HHL, M-DH, HIES
Nauru	HIES							HHL		PHC		HIESM-DH

New Caledonia	Agric		PHC				LFS	PHC, HIES	DHS, LFS	LFS	LFS	LFS
Niue				HIES		PHC		Agric		Covid, Agric	PHC	
Palau	PHC		HIES	PHC, Agric					PHC, Agric			HIES
Papua New Guinea					DHS					HIES	HHL	PHC
Samoa	LFS	Busin, HIES	DHS	Agric	PHC	LFS	HIES	Agric, M-DH	Agric, Covid	PHC, Other	LFS	HIES, Disab
Tokelau		PHC		HIES	PHC			PHC	Covid		PHC	Disab
Tonga	DHS			Agric, HIES	PHC	Busin	LFS, Disab	MICS		HIES, PHC		Agric, LFS
Tuvalu	PHC			HIES		PHC		MICS			HIES, PHC	Disab
Vanuatu (Republic of)		DHS	Disab		PHC			HIES	PHC	LFS	Agric, Busin	M-DH
Wallis and Futuna		PHC	Agric				PHC	HIES	DHS			PHC

*Legend - Agric: Agricultural census / survey; Busin: Business survey; Covid: COVID-19 Rapid Assessment Survey; DHS: Demographic and Health Survey; Disab: Disability survey; HIES: Household Income and Expenditure Survey; HHL: Household Listing; LFS: Labor force survey; MICS: Multiple indicator cluster survey; M-DH: Multiple Indicator Cluster Survey with Demographic and Health Survey modules; Other: Other Census and Surveys; PHC: Population and Housing Census*

7. These surveys are carried out at the household level. In contrast, small-scale fisheries are usually monitored at the level of fishing units, boats, or fishers. However, in many countries, small-scale fisheries combine a high degree of heterogeneity in practices and socio-economic profiles, making it particularly complex to estimate fishing effort, catches and the economics of fisheries. An adapted approach is needed to capture the pluri-activity of fishing households (fishing, agriculture, animal husbandry, handicrafts, and/or working for wages) which is a common feature of small-scale fisheries in most Pacific Island countries. From this perspective, the household is the most effective unit of observation. Moreover, it is common to many disciplines and is already widely used in surveys conducted in the region.
8. These national surveys generally include questions that provide direct or indirect information on households' activities and sources of income. Where they occur, fishing activities could be captured, as well as their contribution to the household's food supply, incomes, and expenses.
9. Among these surveys, population censuses are of particular interest as they are not based on a statistical sample of the population, but exhaustive monitoring of all localities and households at the national level. Data collected can be analysed to identify the different characteristics of fishing households and their practices, and their distribution across the country according to the various administrative units and boundaries.

### *An application to Solomon Islands*

10. For the Solomon Islands, the authors used data from the 2019 general population census.<sup>4</sup> In this survey, variables (i.e., questions) dealing with household activities were selected, and statistical analyses were conducted consisting of a principal component analysis (PCA, described in paragraph 12) and then a

<sup>4</sup> Solomon Islands National Statistics Office (2019) Population and Housing Census.

hierarchical classification.

11. Three key outputs were expected from the analyses: (i) a typology of fishing households, as they may fish professionally or primarily for home consumption or supplemental income, with very different frequencies of fishing trips;<sup>5</sup> (ii) a geographical breakdown of the typology (on a decreasing scale by provinces, constituencies (electoral districts), wards, agglomerations).<sup>6</sup> Based on these first two outputs, (iii) a sampling plan can be defined to pursue a representative sample of the different types of fishing households across geographical levels.
12. Thirteen questions from the national census were considered to describe household activity and assign households to a group. Those questions cover household equipment, eating habits, fishing activities, other activities, and sources of income. Of the 132,483 households identified in the census, 70,380 are not involved in fishing activities (53.1%). Among the remaining 62,103 households which are involved in fishing activities (46.9%), of which 13,299 (10.0%) are missing information (no answer to at least one of the selected questions) needed to be assigned to fishing household groups characterised below by their most discriminating and representative modalities. A Hill and Smith analysis (Hill and Smith 1976), a PCA on quantitative and qualitative variables (Dray and Dufour 2007), was performed for the remaining 48,804 fishing households (36.8%).
13. The dendrogram obtained from the hierarchical clustering (see Figure 1) enabled us to classify households into four main categories, in addition to the non-fishing households and the fishing households with missing information.

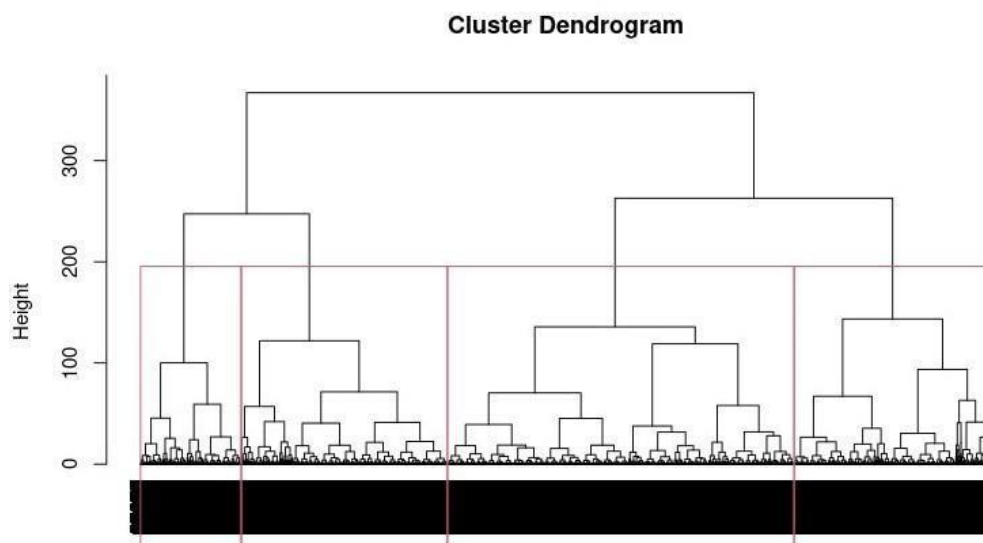


Figure 1: Cluster dendrogram showing typologies of fishing households in Solomon Island

14. The fishing households with missing information were statistically reassigned to one of these categories, and the following groups were established:

- Group 0: Non-fishing households (70,380).

<sup>5</sup> Future surveys should distinguish whether the frequencies of fishing trips are actually different or rather the intensity of the fishing practices and the outputs of the activities.

<sup>6</sup> Solomon Islands administrative levels used for populations statistics are: 0 (country), 1 (province), 2 (constituency), and 3 (ward). (United Nations OCHA HDX – Solomon Islands Subnational Population Statistics. <https://data.humdata.org/dataset/cod-ps-slb>)

- Group 1: Professional fisher households (11,302 identified, estimated to 14,364).
- Group 2: Subsistence-sea-fishing farmer households (19,889 identified, estimated to 25,310).
- Group 3: Subsistence-sea-fishing wage-earner households (11,832 identified, estimated to 15,181).
- Group 4: Subsistence-inland-fishing farmer households (5,781 identified, estimated 7,248).

15. The analysis of the census and hierarchical clustering allows the breakdown of households by geographical and administrative level. The figures below present a representation of this breakdown by provinces (figure 2) and wards (figure 3).

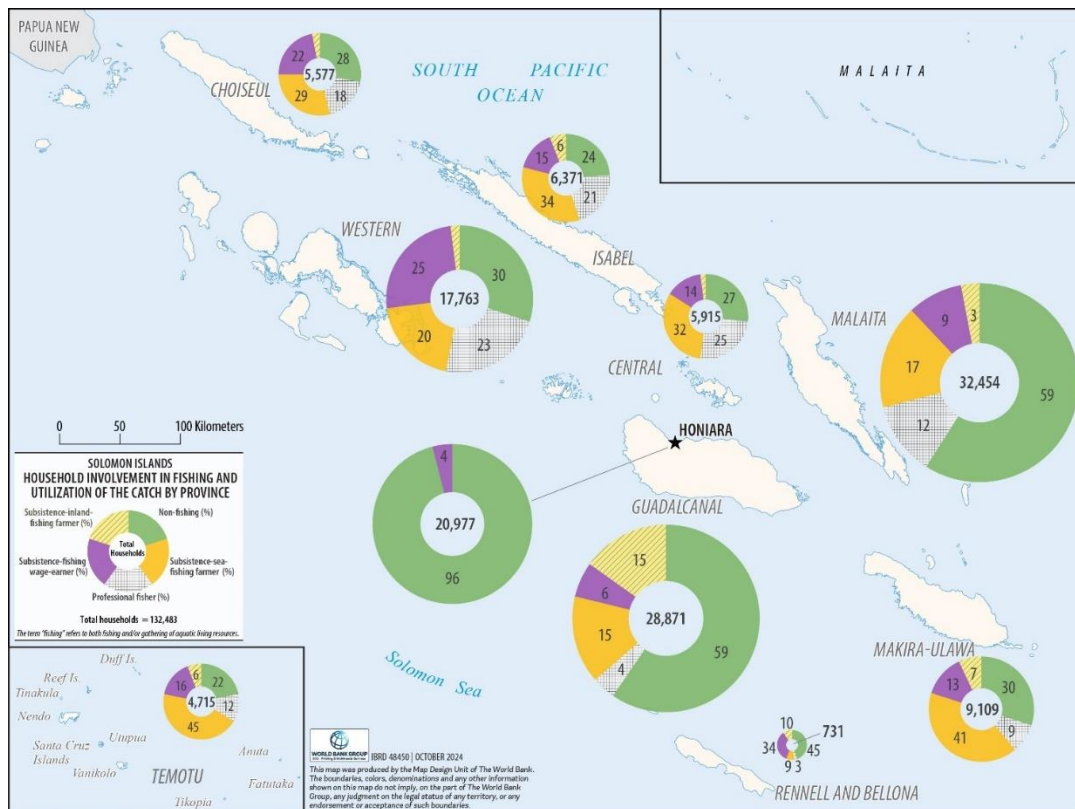


Figure 2: Distribution of households according to the categories of involvement in fishing by province

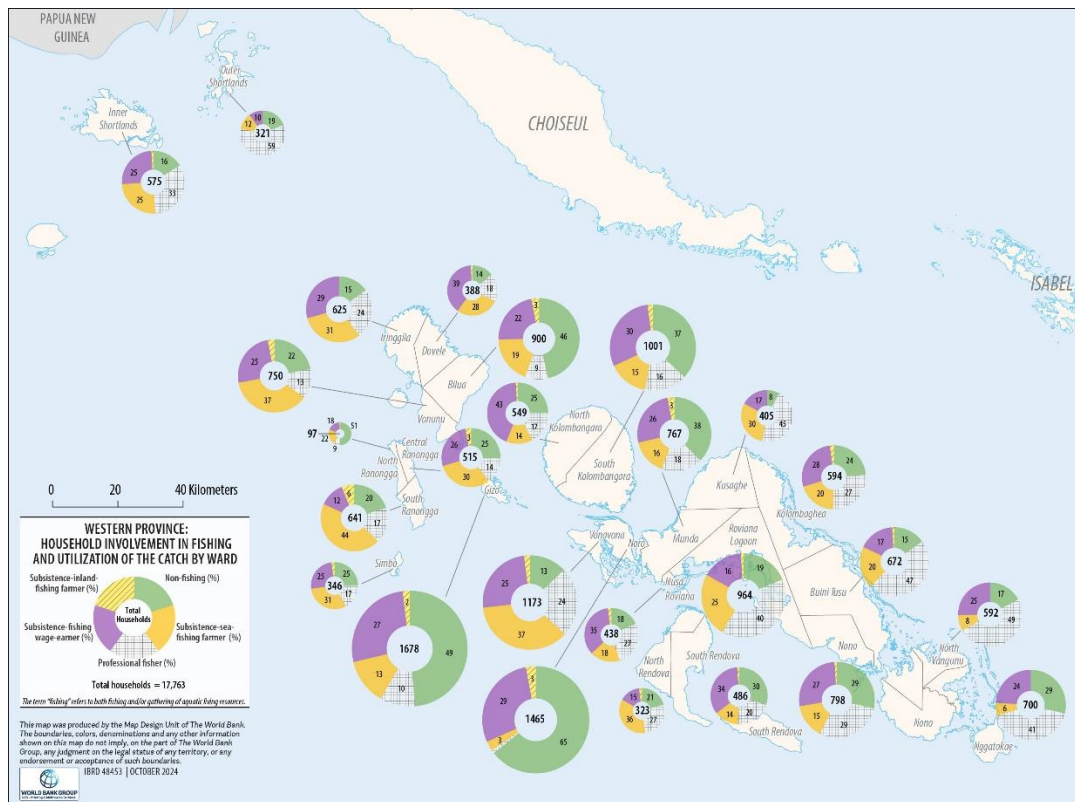


Figure 3: Distribution of households according to the categories of involvement in fishing by ward for the Western Province

### Proposition for monitoring small-scale fishing activities in Solomon Islands

16. These analyses of the national census data provide a statistical framework that can be used to robustly extrapolate at the national level the data monitored from a representative sample of fishing households.
17. Pragmatic geographical stratification can be done based on the importance of the strata (in terms of number of fishing households, main activities, representation of diverse groups, and the distance and accessibility of the area). Due to logistical, financial and human constraints, it would be difficult to collect data from all 10 provinces.<sup>7</sup>
18. Including only the three main provinces in the sample, which together account for 60.5% of fishing households in all categories, is an option:
  - Guadalcanal: 19.1% (11,837 fishing households)
  - Malaita: 21.4% (13,268 fishing households)
  - Western: 20.1% (12,495 fishing households)
19. These three provinces represent 63.2% of the total number of professional fisher households, 53.9% of the total number of subsistence-sea-fishing farmer households, 60.8% of the subsistence-sea-fishing wage-earner households and 77.7% of the total number of subsistence-inland-fishing farmer households. They also reflect a diversity of geographic, economic, and social characteristics such as population concentration, ethnicity, distance from the capital city, access to fishing grounds, and other

<sup>7</sup> The term "province" is used here for the nine provinces and the capital, Honiara.

factors.

20. To simplify the logistics of the monitoring survey, it is also possible to select the administrative units to be surveyed in the three selected provinces. In these three provinces, nine constituencies represent 41.7% of all fishing households at provincial level and 25.2% at the national level. The proposed sampling areas could be located in these nine selected constituencies, as shown in Table 2.





Table 2. Number of households in each category of fishing households in the selected constituencies. (The values in brackets represent the percentage of fishing households in category in the selected constituency relative to the total number of fishing households in the same category across the province)

Province	Selected constituency	Professional fisher households	Subsistence-sea-fishing farmer households	Subsistence-sea-fishing wage-earner households	Subsistence-inland-fishing farmer households	Total
Guadalcanal	Central Guadalcanal	42 (3.4%)	187 (4.2%)	227 (12.3%)	978 (22.8%)	1,434 (12.1%)
	East Guadalcanal	240 (19.5%)	843 (18.9%)	259 (14.0%)	391 (9.1%)	1,733 (14.6%)
	West Guadalcanal	388 (31.6%)	764 (17.1%)	197 (10.6%)	205 (4.8%)	1,554 (13.1%)
Malaita	Baegu-Asifola	486 (12.7%)	288 (5.2%)	172 (6.0%)	58 (5.7%)	1,004 (7.6%)
	Lau-Mbaelela	739 (19.3%)	343 (6.2%)	297 (10.4%)	48 (4.7%)	1,427 (10.8%)
	Small Malaita	372 (9.7%)	1,345 (24.2%)	342 (11.9%)	103 (10.1%)	2,162 (16.3%)
Western	Marovo	1,122 (27.9%)	345 (9.5%)	647 (14.3%)	16 (5.0%)	2,130 (17.0%)
	South New Georgia-Rendova	645 (16.0%)	597 (16.4%)	569 (12.6%)	49 (15.4%)	1,860 (14.9%)
	West New Georgia-Vonavona	543 (13.5%)	679 (18.7%)	1,061 (23.5%)	88 (27.7%)	2,371 (19.0%)
<b>Total of the 9 constituencies</b>		<b>4,577</b>	<b>5,391</b>	<b>3,771</b>	<b>1,936</b>	<b>15,675</b>



<b>% of all fishing households in the category (nationwide)</b>	<b>31.9%</b>	<b>21.3%</b>	<b>24.8%</b>	<b>26.7%</b>	<b>25.2%</b>
---	--------------	--------------	--------------	--------------	--------------

21. In summary, the data collection can be based on cross-stratification. The country is divided into 10 provinces. Three of the most important, in terms of fishing households, are selected. Within each selected province, three constituencies representative of the typology of fishing households have been identified for monitoring. A sample of fishing households (Figure 3), representative of the four defined fishing household groups, can then be surveyed.

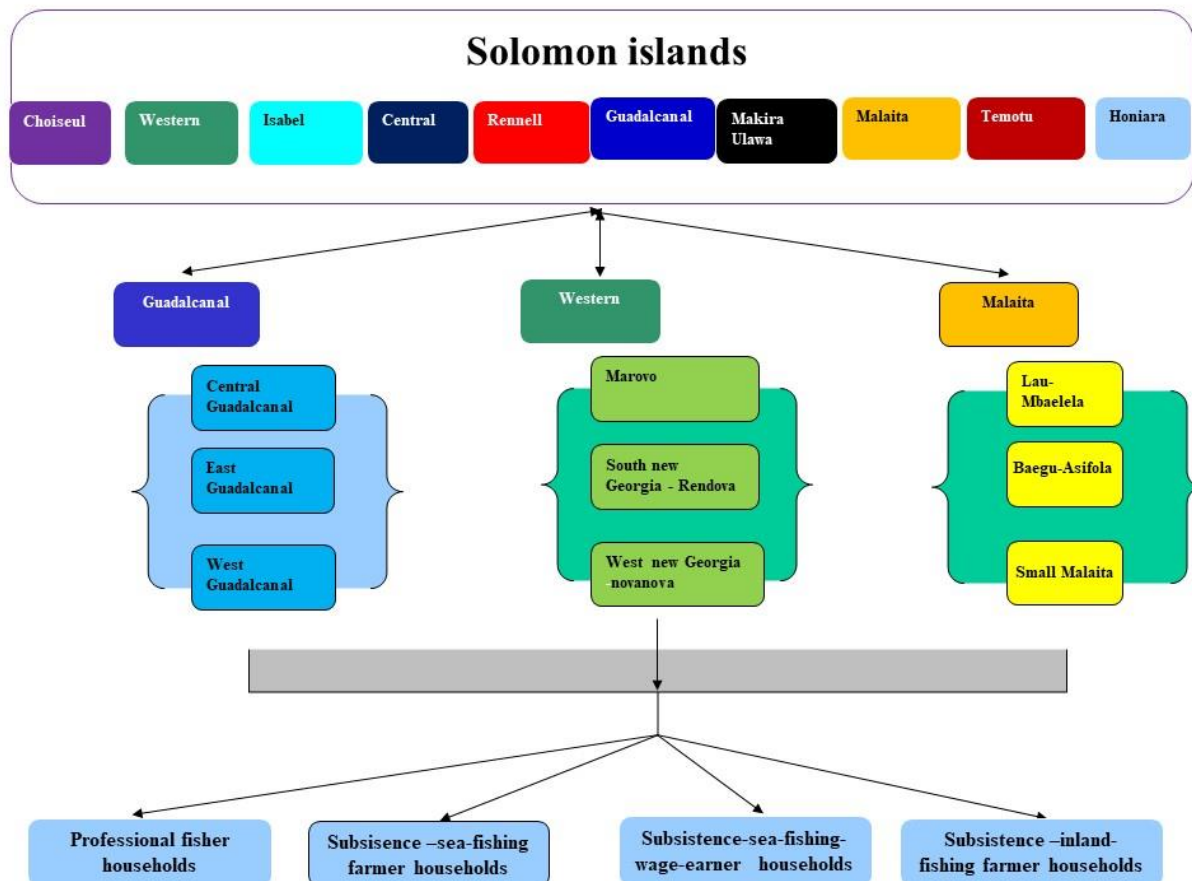


Figure 4: Geographical stratification for the sampling plan

22. Monthly monitoring for a limited period, for instance, 10 days in a row, of the selected fishing households can be organised in each of the selected constituencies with several types of surveys carried out:

- A census of all households present in the sampling area at the start of the monthly survey period.
- A daily monitoring of fishing activities in a selected sample of fishing households, chosen randomly at the starting of the program.
- A daily socio-economic monitoring consisting of the same selected sample of households.
- A daily catch landing survey for any fishing unit (with or without a boat) bringing catch in the monitored area, i.e., not automatically the selected households.

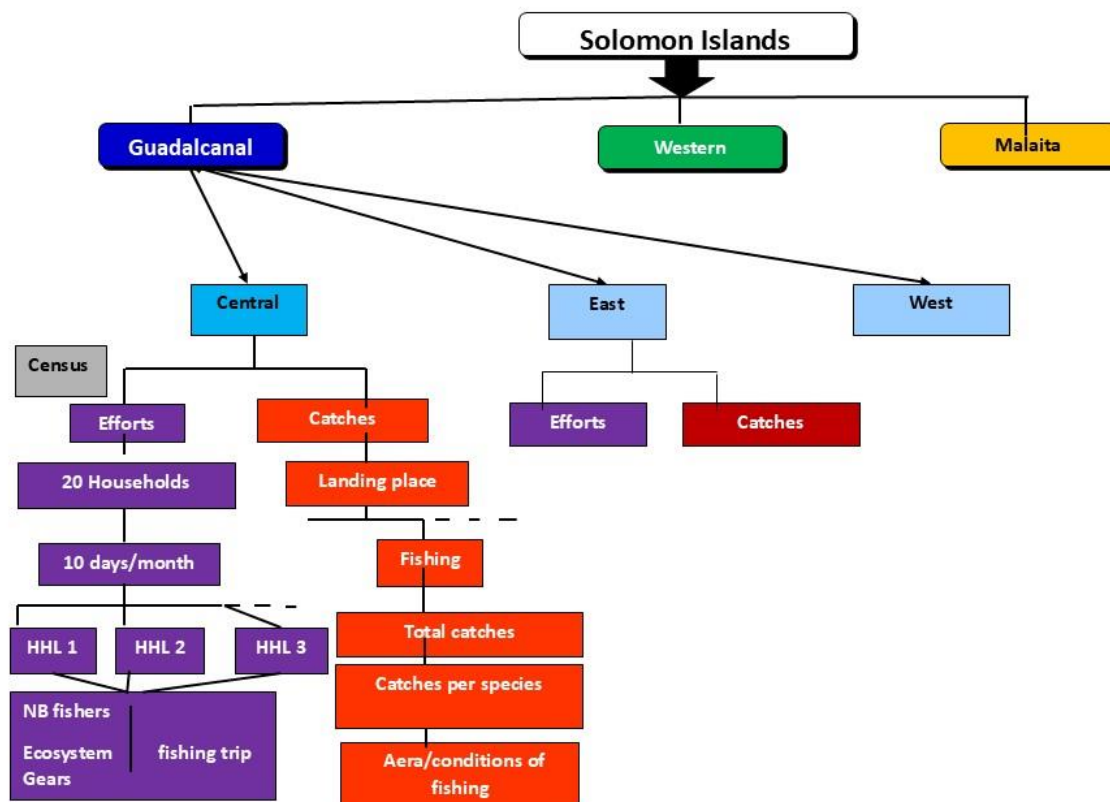


Figure 5: Proposition of sampling design for data collection operations in each of the selected provinces and constituencies

23. The most difficult step remains, however, to configure the sampling system, taking into account logistical difficulties, the cost of operations and the need to put in place a sustainable system. Thus, the size of the sampling scheme could be:

- Three provinces selected and three constituencies per province
- Number of days and frequency per monitored area for fishing households and catch landing monitoring: 10 consecutive days every month
- Number of fishing households monitored every day per monitored constituency for the household activity and socio-economic questionnaires: 20
- Number of fishing units surveyed every day for 10 days per month for catch landing surveys: depending on fishing activities in the locality surveyed.
- Choice of part-time or full-time surveyors, to be determined based on local conditions and availability of suitable surveyors/enumerators.

#### Data input, storage, analysis and processing

24. Data collection: Various computer software, with data entry and processing procedures organised in survey modules, have historically been developed by different countries, SPC or other organisations, such as FAO for small-scale fisheries statistics. As the information collected under the proposed methodology is relatively standard, some of these software, modules or procedures

can be used directly. Activity surveys are the exception, as they are carried out at household level instead of the fishing unit level, and will require adapted procedures.

25. The IKASAVEA application developed by SPC's Fisheries, Aquaculture and Marine Ecosystems Division (FAME) allows or will allow facilitated data collection, transfer, and processing for market surveys, landing surveys, socioeconomic surveys, and community surveys to be entered via an offline digital interface.
26. It would be beneficial to use and interlink these tools, some of which, like IKASAVEA, are currently being adopted by the countries' fisheries departments, and to capitalise on SPC's know-how for this purpose, as well as training, technical assistance, maintenance and data storage capacities.
27. In order to process and extrapolate the sample data to national and sub-national levels, existing processing chains such as PECHART, ARTFISH, PPEAO, etc. can be used. However, these softwares are no longer maintained and upgraded. Meanwhile, FAO is deploying worldwide and further developing the CALIPSEO software, which is designed for this purpose. It would seem preferable to consider this software, for time and cost savings and for ensuring product maintenance and development, as well as technical support and training.
28. As the extrapolation procedures are fairly standard, with no doubt, CALIPSEO has the required potential. However, adapting its processing chain to household questionnaires will require notable efforts.

### *Conclusions*

29. This paper presents a statistical framework and sampling design that can provide national governments with the information they need to manage small-scale fisheries in an informed way and capture their real contribution to national and local economies. The household as the unit of observation and analysis captures the pluri-activity dynamics that are an important pattern in small-scale fisheries, and can reveal varying levels of dependency on fisheries, which can inform targeted support and interventions.
30. The proposed framework provides all the information necessary for the characterisation and assessment of small-scale fisheries: typology and geographical distribution of fishing households, total catches, by species, trophic level, size, fishing gears, and biotopes at the national, regional and sub-regional levels. It also permits the economic monitoring of households, including gender dimensions, and the identification of strategies developed in terms of fishing and more broadly in terms of pluri-activity. All these results are essential for a good understanding of small-scale fisheries and their informed management.
31. This analytical approach consists of re-analysing and re-interpreting existing data using new methods and new angles of analysis. The aim is to maximise utility by collecting as little new data as possible and drawing more conclusions or lessons from the information already available. It is a parsimonious approach based on efficient and optimised use of available resources, minimising (but not eliminating) the additional effort or data required.
32. Indirectly, the proposed statistical framework would foster closer co-operation between SPC divisions, in particular between SDD and FAME and the integrated Pacific Data Hub programme.
33. The proposed approach is easily replicable in other PICTs and can be adapted to their context and needs and the type of national data available to them.

## References

- Ayilu R.K., Fabinyi M. and Barclay K. 2022. Small-scale fisheries in the blue economy: Review of scholarly papers and multilateral documents. *Ocean and Coastal Management* 216. doi: 10.1016/j.ocecoaman.2021.105982
- Dray S. and Dufour A.B. 2007. The ade4 package: implementing the duality diagram for ecologists. *Journal of Statistical Software* 22(4): 6. doi: [10.18637/jss.v022.i04](https://doi.org/10.18637/jss.v022.i04)
- Gillett R.E. and Fong M. 2023. Fisheries in the economies of Pacific Island countries and territories (Benefish Study 4). Noumea, New Caledonia: Pacific Community. [https://www.spc.int/DigitalLibrary/Doc/FAME/Manuals/Gillett\\_23\\_Benefish4.pdf](https://www.spc.int/DigitalLibrary/Doc/FAME/Manuals/Gillett_23_Benefish4.pdf)
- Gillett R. and Tauati M. I. 2018. Fisheries in the Pacific. Regional and national information. *FAO Fisheries and Aquaculture Technical Paper No. 625*. Apia, FAO. <https://www.fao.org/3/i9297en/i9297EN.pdf>
- Hill M.O. and Smith A.J.E. 1976. Principal Component Analysis of Taxonomic Data with Multi-State Discrete Characters. *Taxon* 25(2–3): 249–255. doi:10.2307/1219449.
- SPC - Pacific Community. 2015. A new song for coastal fisheries pathways to change: the Noumea strategy. Noumea, New Caledonia: Secretariat of the Pacific Community. 28 p. [https://www.spc.int/DigitalLibrary/Doc/FAME/Reports/Anon\\_2015\\_New\\_song\\_for\\_coastal\\_fisheries.pdf](https://www.spc.int/DigitalLibrary/Doc/FAME/Reports/Anon_2015_New_song_for_coastal_fisheries.pdf)
- SI-MFMR - Solomon Islands Ministry of Fisheries and Marine Resources. 2019. Solomon Islands National Fisheries Policy 2019–2029: A policy for the conservation, management, development and sustainable use of the fisheries and aquatic resources of Solomon Islands. MFMR, Solomon Islands. <https://faolex.fao.org/docs/pdf/sol188935.pdf>