

SOCIOECONOMIC ASSESSMENT OF VILLAGES IN THE TIGAK AND TSOI ISLANDS, NORTHERN NEW IRELAND PROVINCE, PAPUA NEW GUINEA



**RESULTS OF A SOCIOECONOMIC SURVEY UNDERTAKEN AT 11 COMMUNITIES IN
NEW IRELAND PROVINCE TO COLLECT BASELINE INFORMATION AND INFORM
THE DEVELOPMENT OF MARINE RESOURCE MANAGEMENT PLANS**

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EXECUTIVE SUMMARY

Since 2014, WCS PNG have been working with 11 communities in New Ireland province to establish fisheries management plans. The two year process has involved numerous information exchange initiatives between WCS and communities to establish the requisite information environment for management that meets ecological and socioeconomic objectives. Key to this process has been the collection of socioeconomic data and information through household and key informant interviews, of which 373 and 68 were conducted, respectively. Survey instruments were designed to address information needs according to the following four themes: 1) demographics; 2) fishing activities; 3) marine resource dependency, and; 4) factors influencing the capacity and willingness of communities to undertake and comply with fisheries management. Surveys were conducted to assemble baseline data for current and future WCS projects and to inform the development and implementation of fisheries management rules. Of the latter objective, key findings and management recommendations are as follows:

- High rates of population growth in some communities will continue to place additional pressures on marine resources, which are likely to require adaptive management or alternative income and subsistence options in order to sustain the growing population.
- Low incomes in all communities indicate that costs associated with fisheries rules, such as those requiring gear changes, will be difficult to absorb by fishers and may need to be subsidised by management partners.
- Reciprocal fishing access rights based on mutual clan identification entails additional management challenges which may be met through expanding awareness efforts more broadly and by up-scaling management to multi-village units.
- The concentration of finfishing effort around spawning sites and times will impose challenges for management initiatives designed to protect spawning fish. A transfer of fishing effort from vulnerable sites and times may be achieved through FAD deployment.
- The substantial involvement of women fishers underscores the need for a workable understanding of local gender dimensions as they relate to fishing and resource management and the proportional representation of women in the decision-making process.
- All communities were highly dependent on locally caught seafood for subsistence consumption. However, for income generation, Tigak communities were more dependent on artisanal fishing than Tsoi Island villages as expressed by the proportion of seafood based primary occupations and the contribution of seafood based income to total household income.
- A lower proportion of seafood based occupations were recorded in Salipiu and Ungakum, where communities had the space and soil quality to sell and trade surplus garden produce.
- The high marine resource dependence of all surveyed communities suggests that management measures that constrain catches will make it increasingly difficult to meet basic food and cash needs, suggesting a role for livelihood diversification in maximising socioeconomic and sustainable fisheries objectives.
- For villages with existing management arrangements, the Village Court system has been largely ineffective in addressing non-compliance. Future management efforts will need to address this by providing technical and logistical support to enable these institutions to facilitate effective management.

1 INTRODUCTION

Coastal fisheries in New Ireland, Papua New Guinea (PNG) are predominantly low-investment, multi-species and multi-gear fisheries operated at the village level to support subsistence and artisanal needs. Located within the Coral Triangle, New Ireland villagers have access to a broad assemblage of reef, offshore, seagrass and mangrove-associated fisheries. While low human populations and associated fishing pressures have likely had minimal impact on fisheries health for thousands of years (Dalzell, 1998), more recent population pressures coupled with growing needs for cash, market development and more efficient fishing gears are placing unprecedented pressures on coastal stocks. Climate change impacts are likely to place additional pressures on marine resources and dependent livelihoods.

While some Melanesian coastal villages have applied traditional fisheries management dating back many years, these measures have focussed more on stockpiling resources for quick harvest for cultural and customary events rather than the promotion of healthy stocks (Johannes, 2002; Cinner, 2005). More recently, reported coastal stock declines in PNG (Bell *et al.*, 2009) have necessitated the consideration of science-informed fisheries management to safeguard food and income security for coastal populations who, by virtue of their high dependence on marine resources, are especially vulnerable to resource depletion. In the absence of adequate coastal management support from national and provincial governments, and with limited capacity for effective management at the village-level, partner agencies including non-governmental organisations (NGOs) continue to work alongside villages in some areas to implement management initiatives.

Management partnerships face the challenge of finding effective strategies to secure and enhance livelihoods for growing populations while restoring depleted stocks and adjusting exploitation to sustainable levels. However, fisheries management measures are only effective if they are readily adopted and therefore need to blend into the local socio-economic, socio-ecological and cultural context. Ignorance to these contexts, in communities where fisheries are central to nutritional, social, cultural and (increasingly) economic well-being will likely result in management efforts that don't meet their objectives, waste significant resources and cause resistance to future management efforts with partner agencies.

Since 2006, WCS PNG has worked with two communities in the Tsoi Islands (Ungakum and Kavulik) plus one community on the south coast of Lavongai (Patitiab) to provide scientific, technical and logistic support in addressing marine resource sustainability. This resulted in the establishment of no-take (tambu) fishing zones in each community plus the development of a marine resource management plan for Ungakum. Since 2014, WCS PNG expanded its management efforts to develop fisheries management plans for 11 communities in northern New Ireland including five each in the Tsoi and Tigak Islands. Central to the approach undertaken has been a focus on key fisheries and their specific management needs and up-scaling management instruments to incorporate inter-village agreements in addition to village-level plans. Concurrent with fisheries catch and effort surveys, focus groups for key fisheries and information/awareness workshops, WCS PNG has conducted socioeconomic surveys with the following objectives:

1. To assemble baseline data as reference material for current and future WCS projects in the Tigak and Tsoi Islands. This includes 'benchmarking' socioeconomic conditions of villages where we are in the process on implementing fisheries management.
2. To inform the development and implementation of fisheries management rules.

In this report, quantitative and qualitative survey results will be described with supporting and contextual insights from concurrently conducted fishing surveys and focus groups.

2 METHODS

2.1 Background and Site Description

New Ireland is located in northern PNG in the Bismarck Archipelago. Total land area, which comprises the main island of New Ireland plus small island groups is around 9600 km². With an estimated population of 157,742 (2011 census), New Ireland has universal basic education, a literacy rate of 77.4% and an average human life expectancy of 58 years. The Provincial capital, Kavieng, is situated at the northern tip of the island. New Ireland is divided into two districts, 9 Local Level Governments (LLGs) and 138 wards. While gold mining revenue contributes to provincial wealth through wages to employees and royalties to landowners, most New Irelanders earn income from sales of copra, cocoa, oil palm, seafood and garden produce.

Eleven villages were canvassed during this survey – five each from the Tsoi and Tigak Islands and another on an island off the south coast of Lavongai. The Tsoi Islands are a 27km long chain of seven low-lying sandy islands that run perpendicular to the east coast of Lavongai, the second largest island in New Ireland Province. The western side of the islands are fringed by a coral reef while the eastern side includes mangroves, seagrass beds and sandflats. The population of approximately 2500 (2011 census) is spread across five communities (Kavulik, Ungakum, Kuliban, Mamion and Tsoilik) and are largely dependent on marine resources for their subsistence and artisanal needs. Their relative isolation from Kavieng (approximately 2 hours by motorboat) restricts livelihood opportunities. All five Tsoi villages are currently working with WCS to implement fisheries management plans. However, Ungakum and Kavulik have worked with WCS since 2006 on fisheries-related projects.

The Tigak Islands comprise over 30 islands scattered between the north-eastern end of mainland New Ireland and Lavongai. WCS are currently working with five communities (on five islands) to implement fisheries management plans. Three of these communities – Bangatan, Tugalob and Salipiu – live on neighbouring islands that have reciprocal fishing access arrangements and are bounded by ecological boundaries (deep channels) on all sides. The three communities also access fisheries from the same mangrove system and extensive seagrass beds that lie between Bangatan and Salipiu Islands.

Liminack and Nonovaul are located on small low-lying sandy islands to the east of Bangatan, Tugalob and Salipiu. Both islands are partly fringed by coral reef and both have access to seagrass beds and mangroves for seafood harvesting.

Patitab is a small community on an island that is separated from the south coast of Lavongai by a narrow channel. Beyond the coral reef that fringes the island, the water attains a depth of 1km about 5km offshore. WCS has worked with Patitab since 2008, when they established a small no-take zone on the reef close to the community. Being the most remote of the eleven sites, livelihood opportunities are limited, as are opportunities to access modern services.

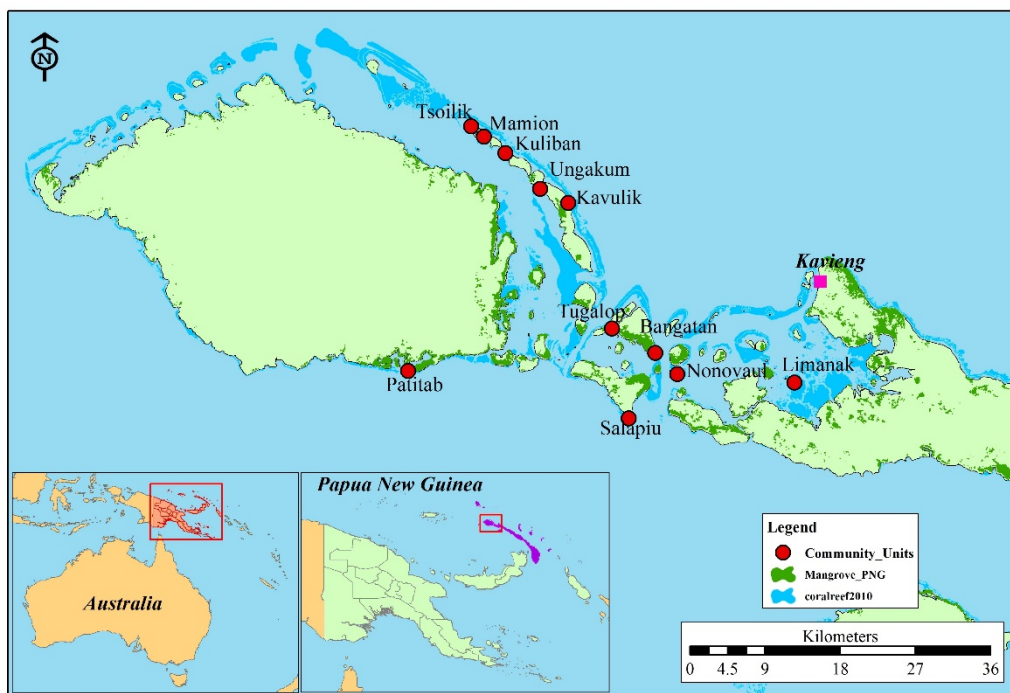


Figure 1. Map of northern New Ireland including sites surveyed

2.2 Survey Development

The survey was designed to complement fisheries work conducted in the Tigak and Tsoi Islands by WCS New Ireland. In an effort to develop and implement fisheries management plans for eleven villages across these island groups, a better understanding of the human dimensions of local inshore fisheries was required. Therefore, survey development focussed on collecting information deemed to facilitate management implementation by better understanding the relationship between communities and key fisheries, plus village-level capacity to navigate and comply with management initiatives. To understand management needs and the potential impact of management initiatives on human welfare, it was also considered important to gain a nuanced understanding of marine resource dependency in each community. Demographic data was also collected in an effort to understand capacity for community changes associated with fisheries management and to inform the development of inter-village management units. The collection of demographic data was also considered important for baseline purposes, particularly in view of WCS's continued work commitments in the region, including non-fisheries related projects.

In light of the underpinning data needs, this survey has been structured according to four 'themes', as follows:

1. Demographics
2. Fishing activities
3. Marine resource dependency
4. Factors influencing the capacity and willingness of communities to undertake and comply with fisheries management

Given the diversity of information needs, it was decided to design and conduct the survey as two complementary components – household interviews and key informant interviews. Household interviews were designed to collect all demographic data, plus data pursuant to various indicators

under themes 2,3 and 4. Most questions in the household survey required short answers, including some questions with closed response categories, though some open-ended questions provided scope for more detailed responses. Some questions in the household survey pertained to the household while others pertained to the individual. Regardless, all data collected through household surveys was designed to be analysed quantitatively.

Key informant interviews contained questions pitched at individuals with a level of knowledge or insight to provide detailed or contextual information pursuant to themes 2, 3 and 4. Data collected through these interviews was designed to be analysed qualitatively.

For both survey components, overall content and question design were partly informed by SEM-Pasifika socioeconomic monitoring guidelines (Wongbasarapim and Pomeroy, 2008), previous WCS New Ireland socioeconomic assessments and monitoring guidelines prescribed by the MacArthur Foundation. Survey instruments were identical across villages, with the exception of Ungakum, where questions on household demographics were excluded: comparable data was collected there in 2012 and has been added to the data analysed for this report.

Both surveys were translated into Tok Pisin and were pre-tested on five respondents each. Accordingly, minor changes were made to both survey instruments.

2.3 Data Collection

Data were collected in two waves. The first wave was conducted over a three-week period in November and December 2014 across five villages in the Tsoi Islands – Mamion, Tsoilik, Kulibang, Ungakum and Kavulik. The second wave was conducted over a two-week period in March and April 2015 at five villages in the Tigak Islands (Bangatan, Tugalop, Salipiu, Limianck and Nonovaul) plus a village on the south coast of Lavongai – Patitab.

The WCS research team was led by a volunteer social scientist and consisted of community facilitators and research assistants who were trained in socioeconomic research techniques. Data collection tools comprised household surveys, key informant interviews and secondary census data. All household surveys and most key informant interviews were conducted in Tok Pisin. A smaller number of key informant interviews were conducted using local (Tok Ples) language.

Household surveys:

Due to the small community population sizes, all households were surveyed in some villages. For most other villages, household sampling was random though a minimum of 35 households was aimed for. For two villages (Kuliban and Salipiu) which are organised into multiple sub-village units, sampling was stratified-random. In these cases, a pre-designated proportion of each strata was chosen for sampling based on village population and distribution estimates provided by the Ward Recorder (Kuliban) and the Village Planning Committee Chairman (Salipiu). Respondents were either male or female household heads or domestic managers.

Key informant interviews:

Non-random purposive sampling (or snowball sampling) was used to select respondents for all key informant interviews. Key informants were generally position holders in various committees (i.e. the Village Planning Committee [VPC] Local Marine Management Authority Committee), community representatives (i.e. womens, law and order, health), church leaders or community elders. The VPC Chairman was the initial contact in each community and was used to guide purposive sampling.

Secondary data:

New Ireland Province census data from 2000 and 2011 was used in this report.

3 RESULTS

3.1 Sampling Summary

A total of 373 household interviews were conducted, which collected data for 1913 people (Table 1). All households in Bangatan and Patitab were surveyed. For other villages, the threshold aim of 35 interviews was attained in all but two villages – Nonovaul and Tsoilik. No interviews were declined but not all households were accessible on survey dates due to non-attendance by household heads. Females comprised 58% of respondents.

A total of 68 key informant interviews were conducted – between five and eight per village. No interviews were refused and females comprised 22% of respondents.

Table 1. Summary data of sampling particulars

	Village	# HH Interviews	# people surveyed (HH)	# KI Interviews
Tigak Islands	Tugalob	38	181	6
	Bangatan	18	86	5
	Salipiu	45	211	6
	Liminack	40	148	6
	Nonovaul	29	154	6
	Patitab	11	56	6
Tsoi Islands	Mamion	38	208	6
	Tsoilik	32	198	7
	Kuliban	41	265	8
	Ungakum	40	202	5
	Kavilik	41	204	7
	Total	373	1913	68

3.2 Demographics

3.2.1 Population and household sizes

Based on 2011 census data, village populations ranged between 63 (Patitab) to 379 (Tugalob) (Table 2). However, 2014/15 population data supplied by the Lavongai LLG Ward Recorder suggests that populations in Tsoilik, Mamion and Kuliban may each exceed 2011 values for Tugalob. This is not supported by population growth rates in Mamion and Kuliban between the last two census years (2000-2011). However, this assertion is supported by high mean household sizes, a high proportion of children (Figure 4) and personal communications with Ward 5 residents who suggest that populations in each village have increased considerably in recent years. Two of these informants also suggest that this is due to many previous residents returning to the area coupled with an increasingly high birth rate.

Negative population growth rates between census years were recorded in Patitab (-0.8%) and Nonovaul (-4.9%). According to one Nonovaul resident interviewed, the large population decline is

associated with limited space, lack of gardening opportunities and people escaping social problems associated with a band of troublesome youths.

Table 2. Village populations, growth rates and household numbers

LLG	Ward	Village	2000 Census	2011 Census	Inter-census Growth Rate (%) ¹	2014/15 ²	Total Households ³	Mean Household ⁴ size
Lavongai Rural	4	Ungakum	183	282	4.9	335	62	5.1
		Kavulik	306	326	0.6	362	72	5
	5	Mamion	178	202	1.2	1482 ⁵	-	5.5
		Kulibang,	241	225	-0.6		-	6.5
		Tsoilik	144	267	8.5		-	6.2
	17	Patitab	69	63	-0.8	56	11	5.1
Tikana Rural	1	Banagatan	131	143	0.8	86 ⁶	18	4.8
		Tugalob	352	379	0.7	-	-	4.8
	2	Salipiu	173	226	2.8	-	-	4.7
		Nonovaul	267	124	-4.9	154	29	5.3
		Liminack	164	271	5.9	-	-	3.7

3.2.2 Sex

With the exception of Salipiu, gender ratios were higher for males than for females (Figure 2). This finding is consistent with New Ireland Province census data from both 2000 and 2011, where the higher ratio of males to females is constant across the entire province and all, bar one, rural local level government districts recorded in 2011.

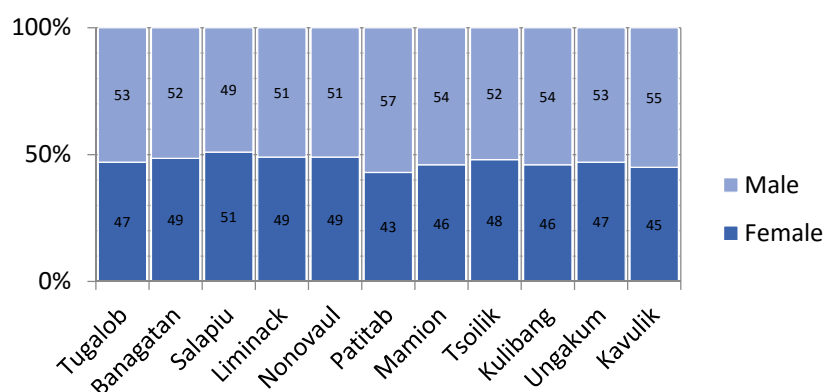


Figure 2. Village gender ratios

¹ Calculated according to the 'straight line' method (i.e. rather than the 'compound' method)

² Data from Lavongai Rural LLG were obtained from Ward Recorders. Data for Bangatan and Nonovaul were based on WCS data as all households in these villages were surveyed

³ Data for Ungakum and Kavulik were provided by the Ward Recorder. Data for Patitab, Bangatan and Nonovaul were based on WCS data as all households in these villages were surveyed

⁴ A 'household' has been defined as the occupants, specifically those that sleep within, a particular dwelling.

⁵ Recent population data provided by the Ward Recorder for Ward 5 was only available at the Ward level.

⁶ 2014/15 population values for Bangatan are inconsistent with census data. This is likely due to the census data including population data from a satellite community – Old Bangatan Station – which was not canvassed in the WCS survey

3.2.3 Age

Around 5% of ages were not known by respondents and were therefore omitted from analyses – this was most prominent in Patitab, Mamion and Nonovaul. With the exception of Patitab, where an average age of just 16.6 years was recorded, average ages ranged between 22.5 (Tsoilik) and 27.2 (Liminack). The proportion of the population in each village 15 years or younger was 43.5% - considerably higher than the PNG national average of 38% (The World Bank, 2015) and indicative of a fast growing population and/or low life expectancy.

The younger age structure of Patitab is seen in Figure 3 whereby almost 60% of the population is below 15 years. However, these values will be somewhat skewed as three older respondents in Patitab were not sure of their ages.

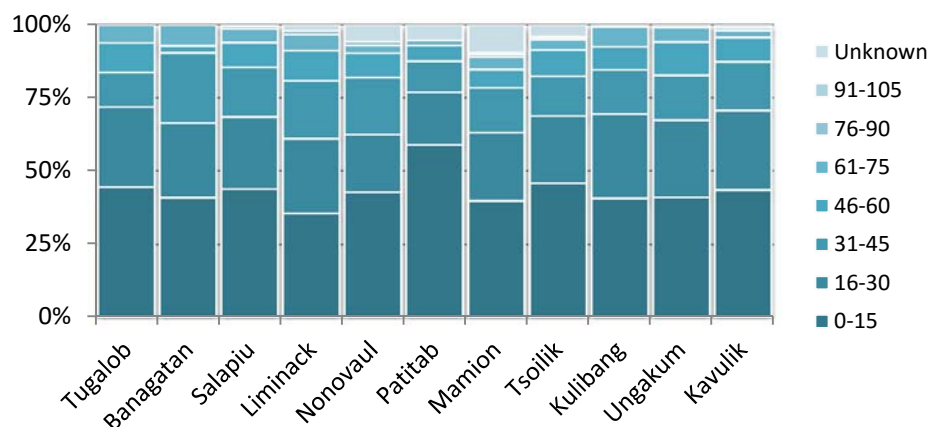


Figure 3. Village age structure

3.2.4 Marital Status

Across all villages, the mean proportions of children, married adults and unmarried adults were 47.3%, 37.5% and 15.2% respectively (Figure 4). While overall proportions were similar between communities, a considerably higher and lower proportion of children were recorded from Patitab (62%) and Liminack (35.8%).

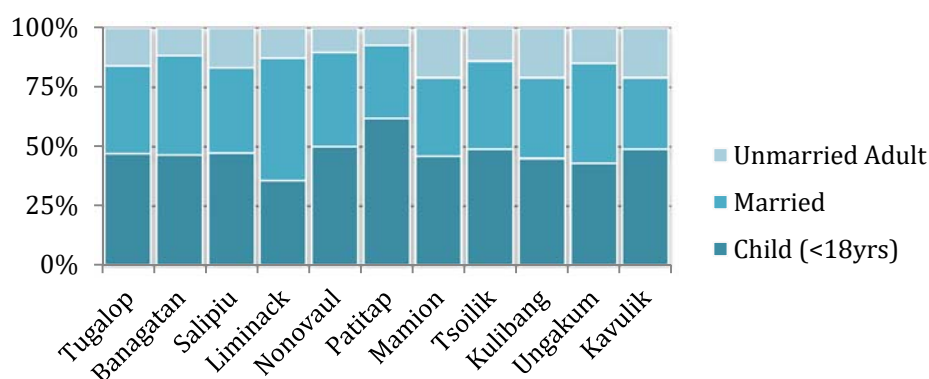


Figure 4. Relative composition of children, married adults and unmarried adults

3.2.5 Migration/Origin

The origin of adults was determined through household surveys according to whether or not they were born in the community they currently reside (people are generally encouraged to marry outside their community) (Figure 5). The proportion of ‘foreigners’ ranged from 12% (Liminack) to 36% (Liminack).

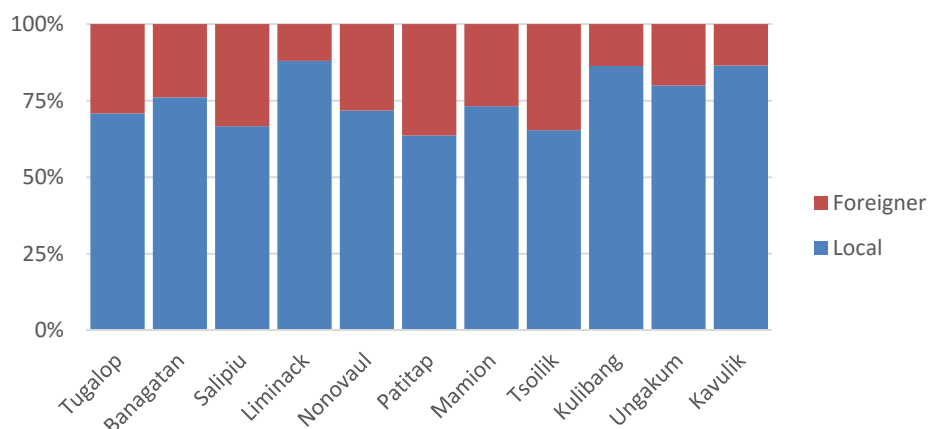


Figure 5. Migration status of villagers

3.2.6 Clan Affiliation

The survey population was comprised entirely of Melanesian Pacific Islanders indigenous to Papua New Guinea. Over 86% of people surveyed across all villages affiliated with clans descended from Lavongai, from which twelve matrilineal clans, symbolised by bird totems (Table 3), have been identified (Kaiku and Kaiku, 2008).

Table 3. Tok Ples and English names for Lavongai-derived clans

Tokples	English
Gila	Parakeet
Kanai	Seagull
Kikiu	Woodpecker
Mani	Fish hawk/ Eagle
Nguma	Crow
Silau	Bush fowl
Sui	Kingfisher
Tien	Starling
Valus	Pigeon
Venge-venge	Hornbill
Yanga	Blue Parrot

Among Tsoi communities, almost all people (95-99%) identified with Lavongai derived clans with Tien, Yanga and Nguma being the most prominent (Figure 6). Lower proportions of Lavongai descended clans were recorded in the Tigak Islands and Patitab: Liminack and Tugalob had the lowest values of 61% and 69%, respectively. The most prominent non-Lavongai derived clan was Tivengau from mainland New Ireland, accounting for between 9% (Bangatan) and 29% (Liminack and Tugalob) of all residents from Tigak Island communities.

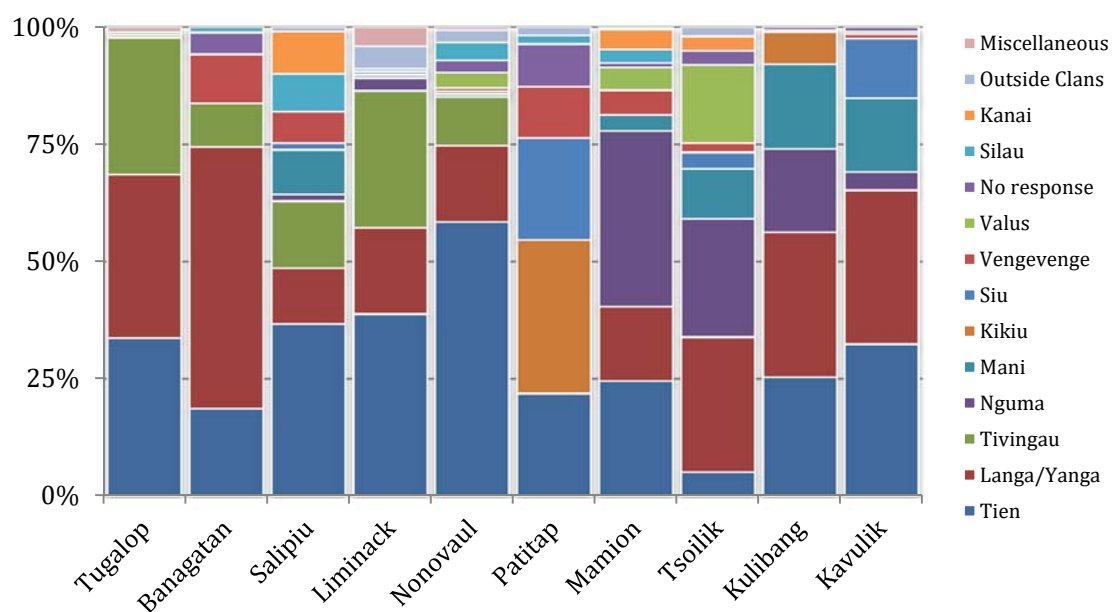


Figure 6. Clan composition of village populations.

3.2.7 Education

Data were collected in order to assess highest education levels attained by respondents (Figure 7). In recognition of the early ages that some people have discontinued formal education throughout the region (particularly among older people), data from all non-current students greater than 8 years were included for analyses.

Overall, 41% of people discontinued formal education before reaching high school. Of those who attended high school, 52% attained a year 9 or 10 level education. Only around 2.5% of respondents attained year 11 or 12 level schooling while a further 5% received education or formal training outside the school system.

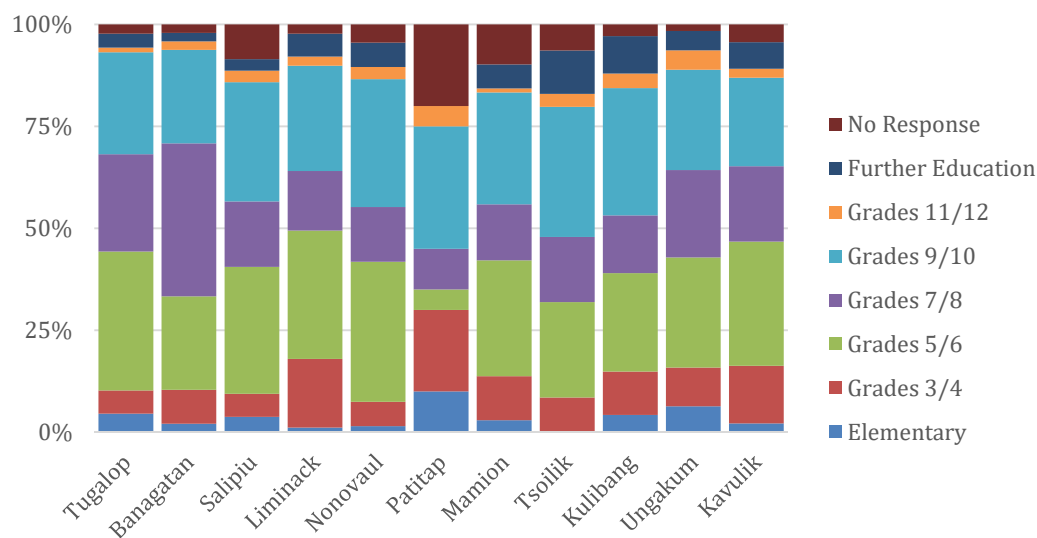


Figure 7. Highest education levels attained by village populations

3.2.8 Religion

All people surveyed identified with a Christian denomination (Figure 8). In total, 11 denominations were represented across the 11 communities, though 67% were associated with the United Church. The next two most prominent churches were the Seventh-Day Adventist and Revival Fellowship Institute Churches, which comprised 15% and 7% of responses, respectively. Liminack had the highest religious diversity, with six Christian denominations while Tugalob and Patitab were comprised wholly of members from the United and Seventh-Day Adventist Churches, respectively.

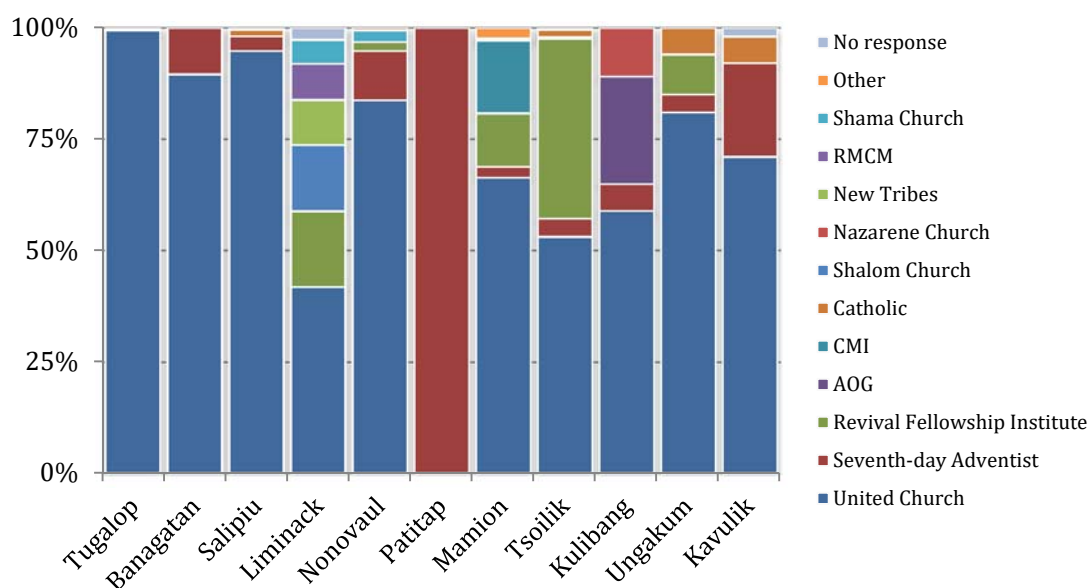


Figure 8. Religious constituency of village populations

3.2.9 Occupation

Primary source of income was determined for all non-current students greater than 8 years (Figure 9). Overall, more than 51% of people relied on the sale of seafood as their primary income source. However, this was considerably higher in the Tigak Islands (70%) than the Tsoi Islands (41%). The proportion of people who identified as unemployed or dependent was considerably lower in the Tigak Islands (4%) than the Tsoi Islands (15%). Conversely, more people were involved in the production and sales of handicrafts in the Tsois (8%) than in the Tigaks (1%).

Approximately 3% and 4% of people reported being formally employed inside and outside their home village, respectively. The former includes positions such as church pastors and school teachers while the latter generally refers to positions held in Kavieng.

The selling of garden produce (including copra) was highly variable between communities, reflecting differences in soil fertility and gardening opportunities. Implications of this for food security, along with income related to the selling of seafood, is discussed further in Section 3.4.1.

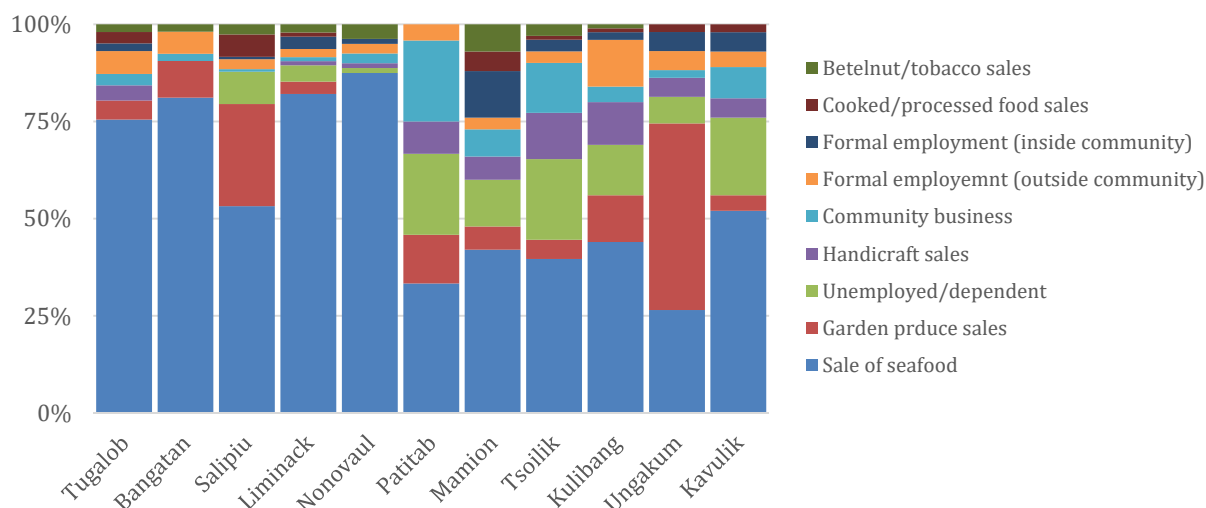


Figure 9. Primary occupations of village populations

3.2.10 Income

Household survey respondents were asked to estimate total household income accrued within the week prior to being interviewed (Figure 10). Across all sites, average weekly income per household ranged from 0-1350 kina, with a mean of 144 kina. Incomes were considerably higher in the Tigak Islands, with all communities exceeding the overall mean. In the Tsois however, only Tsoilik attained the overall income mean while the average weekly household income for Patitab was only 7.7 kina.

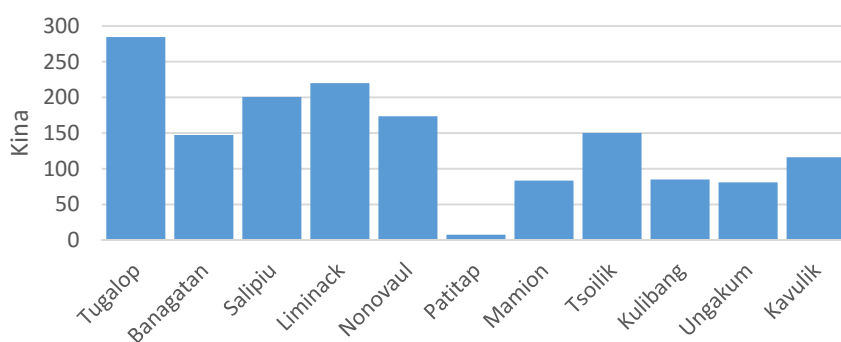


Figure 10. Mean weekly household income of village populations

When examined by income brackets, we see a balanced spread for all Tigak communities with the exception of Bangatan (Figure 11). By contrast, approximately half of all respondents from the Tsoi Islands had weekly household incomes less than 50 kina. For Patitab, all households surveyed had weekly household incomes less than 50 kina.

While these results are insightful, they may not reflect longer term (e.g. annual) household incomes. As only a small minority of respondents were wage earners, temporal variability in sales proceeds needs to be considered. Such variability is likely to be more apparent in remote locations such as Patitab and the Tsoi Islands where sellers may have infrequent opportunities to sell their products.

It also needs to be considered that household incomes are likely to increase appreciably once the moratorium on the sea cucumber fishery ends in 2016.

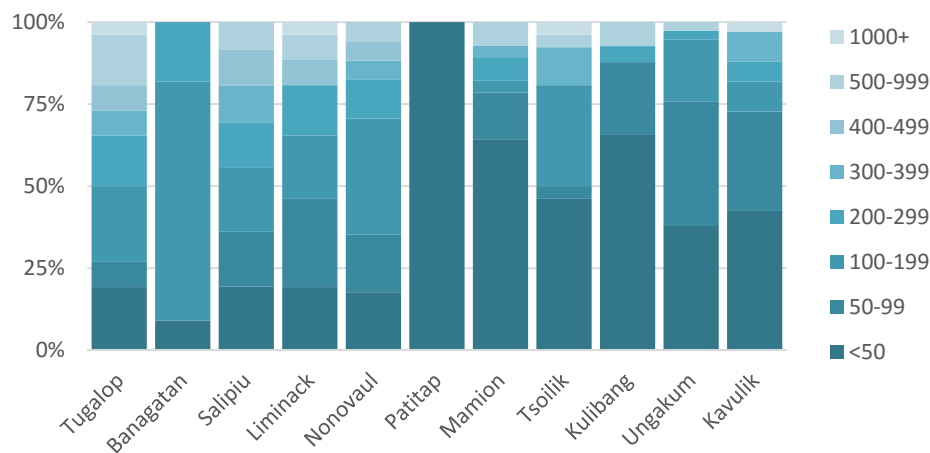


Figure 11. Composition of mean household brackets

3.3 Fishing Activities

3.3.1 Weekly Fishing Trips

Respondents were asked to recall all fishing trips undertaken by members of their household during the week prior to being surveyed. Fishing trips were disaggregated into trips targeting finfish, crustaceans (mainly mud crabs and lobsters) and shellfish. These three categories represented 73%, 17% and 10% of all fishing trips undertaken.

Across all communities, an average of 3.2 trips were undertaken weekly per household. Greatest fishing activity was reported in Ungakum whilst the lowest number of trips were undertaken in Mamion and Nonovaul (figure 12). However, these values are sensitive to temporal variations in fishing activity (due to weather, seasonal variations in fisheries abundance and social/cultural activities) and may therefore not reflect longer term (i.e. annual) fishing activity patterns.

Nonetheless, a relatively high proportion of trips targeting crustaceans in Tugalob, Salipiu, Ungakum and Kavulik reflects the importance of mud crabs for these mangrove-associated communities.

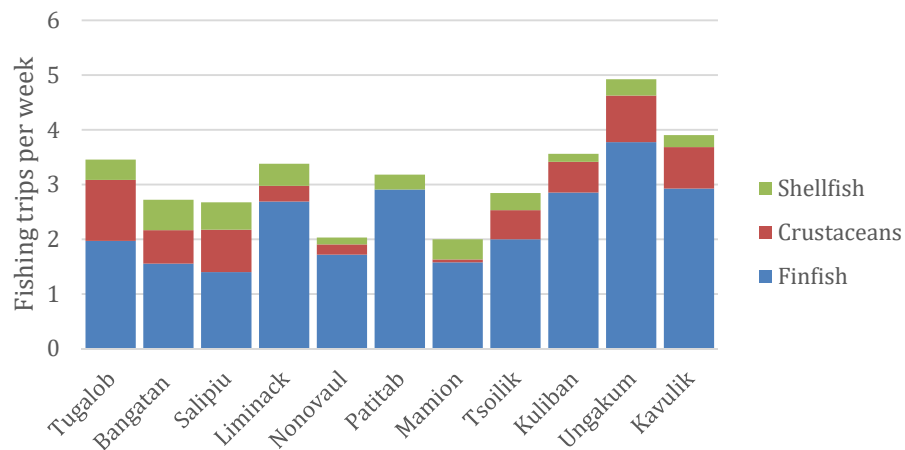


Figure 12. Mean number of weekly fishing trips targeting finfish, crustaceans and shellfish

Fishing activity spanned all demographics though participation in specific fishing activities was generally defined by gender and age. For example, the collection of mud crabs and mangrove shellfish is almost exclusively dominated by women while diving for lobsters and trochus is almost exclusive undertaken by younger men and boys. Fishing for finfish is more evenly divided across genders (see Table 4) and ages though the men (particularly young men) reportedly travel further in canoes and target larger species than women.

Table 4. Disaggregated fishing effort by gender

	Finfish	Crustaceans	Shellfish
Males	64%	40%	12%
Females	36%	60%	88%

3.3.2 Variations in Fishing Activity

During key informant interviews, most respondents indicated three factors that influence fishing activity on a seasonal, monthly and occasional basis. Seasonally, fishing activity is typically reduced from December to February/March (i.e. the monsoon season) due to difficult and dangerous sea conditions. During these times, some fishing effort is transferred from offshore to inshore fishing. Monthly fishing activity is highly regulated by the spawning activity of many fish species which typically either spawn over the full moon or new moon periods. Fishers target these spawning aggregations and known migration routes. On an occasional basis, social and cultural events such as funerals, festivals and annual school closures are typically associated with feasting. Preceding these occasions are periods of heightened fishing activity.

3.3.3 Fishing Gear Ownership

Across villages, an average of eight items of fishing gear were recorded per household⁷. Fishing lines were the most commonly owned item followed by spears, masks and canoes (Figure 13). Dinghies were relatively uncommon, with one owned per 4.4 households. Highest and lowest rates of gear ownership per household was recorded in Bangatan and Patitab. Despite considerable differences in total household gear ownership between communities, the relative proportions of gear types were similar. Nets (primarily gillnets) were an exception to this however – a disproportionately high number (2.1) were owned by Banagatan households.

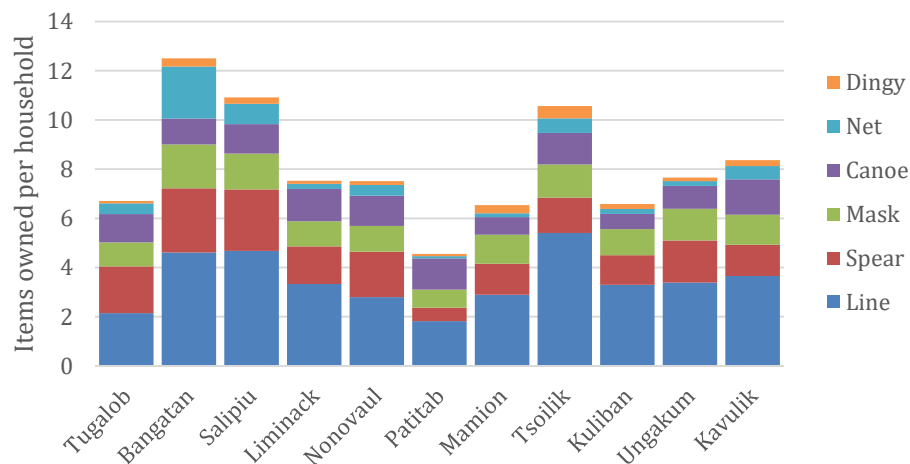


Figure 13. Mean number of fishing gears owned per household

3.3.4 Market Access

Household survey respondents who indicated selling seafood as a primary or secondary occupation were asked to indicate which markets they sold to. There were clear distinctions between Tsoi and Tigak island communities regarding market location (Figure 14), which reflect proximity. The most prominently utilised markets (54%) for Tsoi Island communities are on Lavongai (including the logging camp) while the majority of sellers from the Tigak Islands (66%) sell their seafood in Kavieng (usually the Kavieng market). Also, over 20% of respondents from the Tsoi Islands indicated that they sell seafood to neighbouring villages – a market sector apparent unutilised by Tigak Island communities surveyed.

The values illustrated in Figure 14 are not necessarily indicative of the actual volumes of seafood sold at different markets. It is likely that per marketing exchange, larger volumes (or higher valued seafood items) are sold at larger markets, especially if there are significant time and financial costs associated with accessing them. For example, while markets in Kavieng are only accessed 13% of the time by Tsoi Island villagers, it is likely that the volume or value of items sold per exchange is greater than the volume or value sold within the village or visits to neighbouring villages. The latter markets

⁷ Due to the use of 'closed' survey response categories, fishing other fishing gears such as crab digging sticks and iron rods for prising clams from rocks were not recorded. As such, the values presented are only representative of the items recorded in the survey and may not represent all fishing gears used per village.

may be easily accessed on an opportunistic basis such as when daily catches are surplus to family needs.

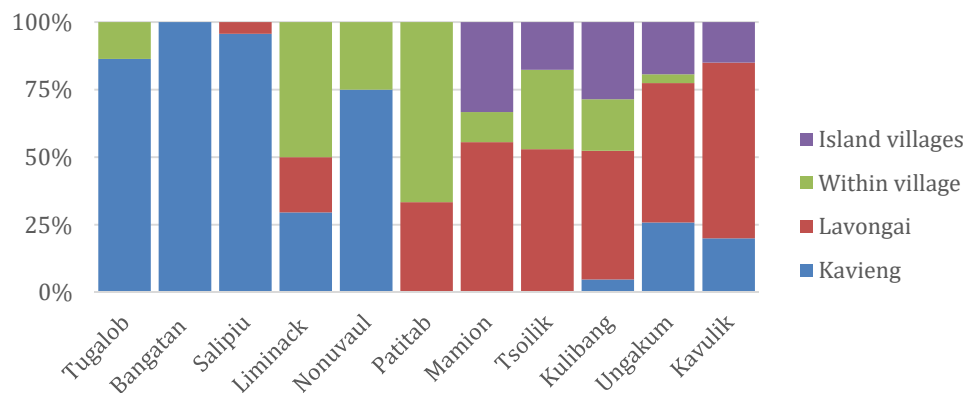


Figure 14. Markets used for selling seafood

3.4 Marine Resource Dependency

3.4.1 Primary and Secondary Occupations

Across communities, more than 51% of people relied on the sale of seafood as their primary income source. Of those who reported a secondary income source, selling seafood constituted 38% of occupations (Figure 15).

The proportion of primary occupations based on selling seafood was considerably higher in the Tigak Islands (76%) than the Tsoi Islands (41%) – likely due to the closer proximity to markets on mainland New Ireland (Figure 14). However, island group differences were not apparent for secondary occupations.

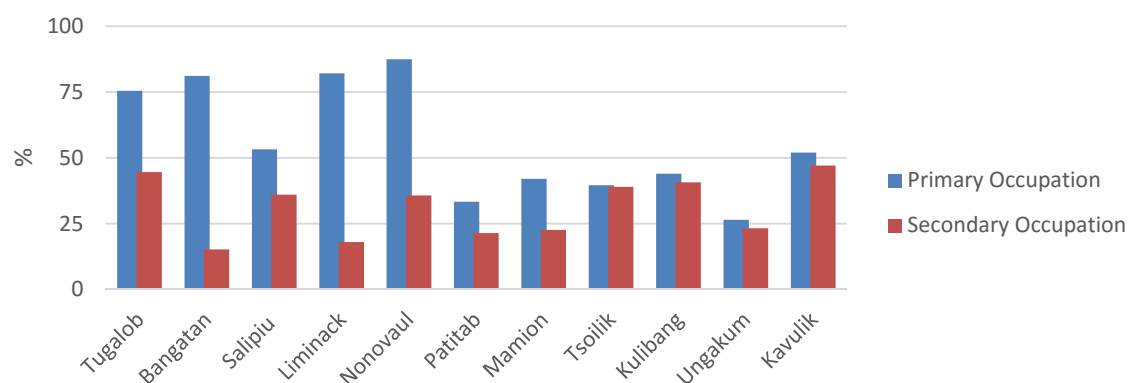


Figure 15. Proportions of primary and secondary occupations based on the harvest and sale of seafood

Of those who reported catching and selling seafood as their primary occupation, 81.1% were involved with finfish, followed by “assorted seafood” (9.1%), mud crabs (5.6%), shellfish (2.8%), lobsters (0.7%), trochus (0.5%) and seaweed (0.2%) (Figure 16). Finfish dominated occupations were observed for all communities except Kavulik where “assorted seafood” and mud crabs defined most seafood based occupations. While finfish dominated seafood-based occupations, crabs and lobsters are likely to make a disproportionately high contribution to household and community incomes due to the high market values attained.

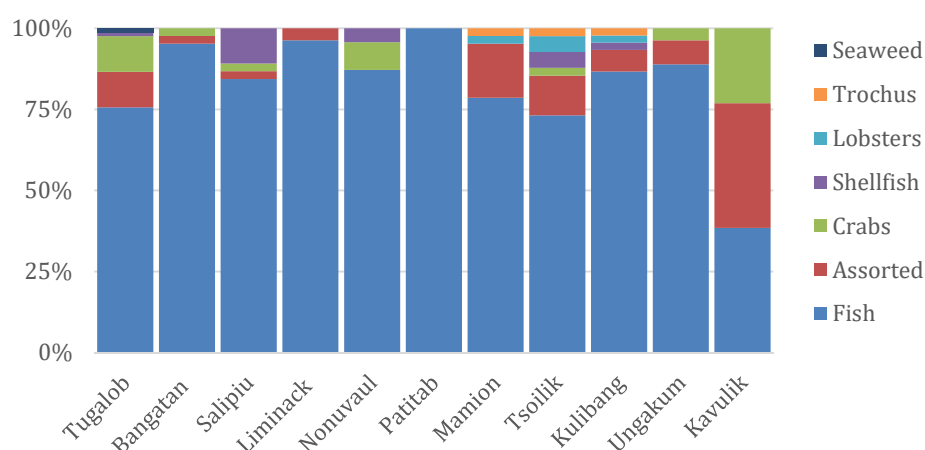


Figure 16. Seafood-based primary occupations disaggregated by harvest category

3.4.2 Seafood-based Income

Overall, income from seafood sales comprised 37.8% of all income generated. The highest and lowest values were from Bangatan (59%) and Mamion (10%) (Figure 17). Consistent with results for seafood-associated occupations (Figure 15), income values were markedly higher for Tigak Island than for Tsoi Island villages. The clear exception to this is Ungakum which had the lowest primary occupation value but the greatest contribution to total income from seafood sales. The reasons for this are unclear, especially as the proportion of occupations based on high value seafood products such as lobsters, mud crabs and trochus in Ungakum are not high (Figure 16). It is likely however that collecting household income values at a weekly rather than an annual level has biased income data associated with seafood sales due to temporal fishing activity variability, as explained in Section 3.2.10. It is also worthy of note that the proportion of seafood sales to total income will probably increase considerably in most communities once the moratorium on sea cucumber harvesting is lifted in 2016.

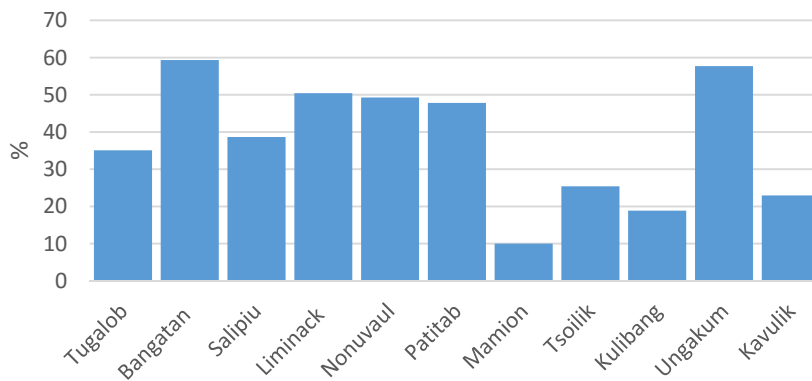


Figure 17. Proportion of seafood based income to total weekly household income

3.4.3 Household Protein Consumption

To understand each communities' reliance on locally caught seafood, respondents were asked how many times various protein-based foods (both seafood and non-seafood) were consumed within their household in the week prior to interview. As a proportion of all protein based foods consumed, values for locally caught seafood ranged from 48% (Mamion) to 86% (Ungakum), with an overall mean of 75% (Table 5).

Table 5. Proportion of locally caught seafood to total protein-based food consumption

Tugalob	Bangatan	Salipiu	Liminack	Nonuvaul	Patitab	Mamion	Tsoilik	Kuliban	Ungakum	Kavulik
83.8	81.8	71.3	78.3	75.1	83.3	48.1	57.4	84.5	85.9	75.9

Fish, shellfish and crustaceans comprised 72, 15 and 13% of the locally caught seafood consumed, respectively (Figure 18). Relative proportions of fish were similar between communities, though there was a greater level of crustacean and shellfish consumption among communities with mangrove access reflecting the consumption of mud crabs and mangrove shellfish (mud clams, mud creepers, blood cockles and mangrove oysters). For communities without direct mangrove access (Tsoilik, Mamion and Kuliban), crustaceans and shellfish consumed included lobsters, reef crabs and giant clams. Greater consumption levels of eggs recorded for the Tsoi Islands is largely due to the presence of megapode birds (*Megapodius* sp.) which lay eggs in the sand in Mamion and Kavulik and are sold and traded to other Tsoi Island villages.

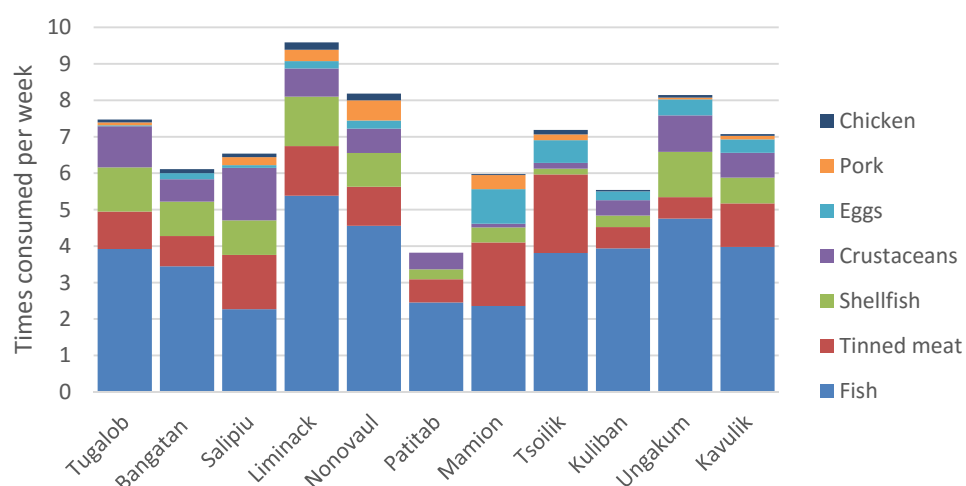


Figure 18. Mean number of times various protein-based food are consumed weekly

3.4.4 Land-based Food Production Opportunities

The capacity to provide village needs for garden produce was assessed across communities using a range of criteria (Table 6). Two communities – Salipiu and Ungakum – had the gardening space and soil of sufficient quality to sell or trade surplus produce to neighbouring communities. Salipiu and Ungakum also had the highest proportion of their working populations involved in producing and/or selling garden produce. Two other communities – Kuliban and Kavulik – were deemed to sell and buy (or trade) similar quantities of garden produce. For these communities, surplus production of crops able to be grown in their soils of limited and/or variable quality are traded for plant-based foods (including sago) able to be grown in better soils on Lavongai.

The remaining seven communities were deemed to be net importers of garden produce owing to poor soil quality and/or limited gardening space. The most limited agricultural opportunities are in Tsoilik, Mamion, Nonovaul and Liminack where low-lying sandy soils restrict gardening to a few hardy species such as bananas, coconuts, paw paw and tapoik. Key informant interviews indicate that rising sea levels and more frequent storm surges are worsening growing conditions by making soils more saline. For Liminack and Nonovaul, most garden produce is purchased in Kavieng though some is traded for seafood with people from Lavongai. For the more remote Tsoi Island communities of Tsoilik and Mamion, fruits, vegetables and sago are typically traded for seafood with people living on Lavongai, including the logging camp. The reliance on Lavongai people for garden produce is apparently making it difficult to exclude them from their fishing waters as Lavongai villagers may suspend the trade that Tsoilik and Mamion need if relationships deteriorate.

Table 6. Assessment of land-based food production opportunities according to various criteria

	Net Production ¹ Employment (%) ² Soil Quality ³ Gardening Space ⁴				Crops Grown	Trading Partners	Items Bought/Traded	Items Sold/Traded with	Comments
Tugalob	I	5	2	2	Kaukau, bananas, beans, pumpkin,	Lavongai, Salipiu	Sago fruit and vegetables	Seafood	Many villagers have their gardens on nearby Kawang Island
Bangatan	I	9	2	1	Tapiok, taro, kaukau, kumu, bananas, sago	Lavongai, Kavieng	Sago fruit and vegetables	Fish and mud crabs	Despite living on a large island, most of the area is mangrove
Salipiu	E	26	3	3	All kinds including sago	Bangatan, Tugalob and other islands	seafood	All kinds including sago	
Liminack	I	3	1	1	Bananas, coconuts, taro, tapiok, taragum	Kavieng	Fruit, vegetable and sago	Seafood	
Nonovaul	I	0	1	1	Bananas, coconuts, taro, tapiok, taragum	Lavongai, Kavieng market	Fruit, vegetable and sago	Seafood	Some villagers grow produce at Salipiu, Siu and Pinigen
Patitab	I	13	2	1	Taro, corn, kaukau, banana, yam, greens, sugar cane, tapiok	Lavongai	Fruit, vegetable and sago	Seafood	
Mamion	I	6	1	1	Bananas, coconuts	Lavongai	vegetables, sago	fish, crabs, dry coconut	
Tsoilik	I	5	1	1	Bananas, coconuts	Lavongai	vegetables, sago	fish, crabs, dry coconut	
Kulibang	S	12	2	2	Kaukau, tapiok, beans, ibika, taro, pumpkin, pawpaw, cabbage, singapore	Other Tsoi villages, Lavongai	vegetables, sago	fish, crabs, dry coconut	
Ungakum	E	48	3	3	Taro, kaukau, tapiok, snake bean, banana, ibika, kumu, sugar cane	Lavongai	sago	vegetables, fish, dry coconut	
Kavulik	S	4	2	2	Tapiok, kaukau, banana, pumpkin, bean, kumu, corn, tomato, ibika	Lavongai	sago	fish, crabs, shellfish	

1 Denotes whether the village is a net 'exporter' [E] or 'importer' [I] of garden produce, based in key informant interviews. If supposed quantities are roughly even, [S] will denote 'same'.

2 The proportion of the working village population who are employed through the growing and/or selling of garden produce

3 Three categories for soil quality are: 1) poor and sandy; 2) intermediate or variable; and 3) productive for most crops. These categories are based on key informant responses and an assessment by the WCS New Ireland Agriculture Officer

4 Three categories for gardening space are: 1) very limited, 2) limited, and 3) ample. These categories are based on key informant responses and an assessment by the WCS New Ireland Agriculture Officer

3.5 Factors influencing the capacity and willingness of communities to undertake and comply with fisheries management

3.5.1 Marine Boundaries and Fishing Access Arrangements

No clearly identified traditional marine boundaries were reported to exist in any of the communities surveyed. Despite this, key informant responses suggest that it is generally deemed unacceptable to fish in waters close to another village unless permission is sought from the Village Planning Committee or if clan interrelationships exist. In most situations however, such interrelationships do exist and therefore fishing access rights are almost always reciprocal. Given the reliance on canoes for fishing transport, fishers typically access locally accessible fishing grounds and rarely travel beyond waters adjacent to immediate neighbours unless specific target species (usually high value species such as trochus and lobsters) are locally unavailable.

Exceptions to reciprocal fishing access include when a community establishes a formal management area such as a tambu reef (usually in collaboration with an NGO). Generally, neighbouring communities are made aware of these restrictions, though they are not always heeded. For example, there were reports of unauthorised outsiders fishing the tambu reefs at Ungakum and Kavulik⁸. Furthermore, some interviewees indicated that many Kavulik residents frequently fish the Kavulik tambu reef. Similarly, only one of the three no-take zones established between Salipiu and The Nature Conservancy is currently being observed. In the case of Patitab, key informants suggest that outsiders are sometimes charged 50 kina for the opportunity to fish in the tambu area co-established with WCS.

Another exception to the general regime of open access fishing grounds is when clans declare management activities for waters adjacent to clan-owned land. Such activities are usually small no-take zones. For the only clan-based management zone identified during the survey (in Tsoilk), there was a high degree of awareness of the location and boundaries.

Despite the reciprocal fishing arrangements, there appears to be an undercurrent of tension and mistrust towards 'outside' fishers in some communities. This appears more palpable in places where people from communities with unproductive or depleted fisheries fish in waters 'owned' by communities with more productive or less depleted fisheries. For example, fishers from Lavongai frequent fishing grounds near Mamion and Tsoilk. These 'outsiders' reportedly use derris root (poison rope) and small-mesh gillnets and have apparently damaged their own fisheries, necessitating an expansion to other waters. Whilst it is generally agreed that these fishers are having a deleterious impact, villagers from Mamion and Tsoilk acknowledge the clan ties that underpin reciprocal fishing access. Villagers are also aware that moves to address the issue could damage trade relationships and therefore access to garden produce.

3.5.2 Existing and Customary Fisheries Management

Key informants were asked a series of questions designed to elicit details of all current and former marine resource management arrangements. Awareness of and practices relating to restrictions on fishing activities can be divided into three categories: 1) co-management arrangements with NGOs; 2) those pertaining to national laws and awareness campaigns, and; 3) customary restrictions.

Co-management arrangements with NGOs

⁸ In one unconfirmed report, over one tonne of lobsters was harvested from the Ungakum tambu reef in January 2016 by unauthorised outsiders.

Three communities have current management plans developed in collaboration with NGOs: Ungakum (WCS), Salipiu (TNC) and Nonovaul (Ailan Awareness). Furthermore, Kavulik developed a draft management plan with WCS in 2014 (which was suspended pending the outcomes of current fisheries work) and Patitab established a no-take zone with WCS in 2008, though no management plan was drafted.

From key informant interviews, there were mixed responses about what the management rules were and how well they were being observed. While most respondents were aware of the location of no-take zones, a level of non-compliance was reported from each community. In the case of Salipiu, only two of the three no-take zones established in 2008 were currently being observed.

With the exception of Patitab, restrictions on gear type (i.e. derris root and small-mesh gillnets) and the harvest size of certain animals (i.e. trochus, lobsters and mud crabs) were also established through co-management arrangements. Most respondents indicated some knowledge of these restrictions, though awareness of rule details was variable. This was especially apparent for rules pertaining to gillnet mesh size restrictions⁹ and the minimum harvest sizes of trochus and lobsters. For Ungakum and Kavulik, where minimum sizes for mud crabs apply, a survey conducted at the Kavieng market in 2014/15 (Frijlink and Kelokelo, 2016) suggests either a poor knowledge of this restriction, or wilful non-compliance. There was a more uniform awareness of derris root bans from respondents interviewed, though this is also prohibited under national regulations (below).

At Nonovaul, Ungakum and Kavulik, rules were reported to be enforced by the Village Planning Committee, usually during Monday community meetings. No respondents mentioned the role of the Village Court system and there was little evidence of sanctions being given for non-compliance. For Salipiu, all respondents reported that rule enforcement was provided through “awareness” by the National Fisheries Authority. This implies confusion over the meaning and role of rule enforcement and/or the apparent absence of enforcement activities undertaken within the community.

National laws and awareness campaigns

There are national laws (including those outlined in the *Fisheries Act 1998*) prescribing the prohibition of poisons and explosives to harvest fish and other animals and minimum harvest sizes for trochus and rock lobsters destined for sale. Most respondents in all communities were aware of the ban on using derris root (a type of poison) though few mentioned the ban on explosives (this is likely a reflection of the relative prevalence of these activities in the region). Some respondents also mentioned minimum harvest size restrictions for trochus and lobsters. It is likely that awareness of the latter is reinforced by buyers who are legally obliged to only buy animals above the minimum size.

Customary Restrictions

Throughout the Melanesian region, the use of small periodically harvested closures implemented by villages or clans has been well documented (Johannes, 2002; Cinner, 2005). Generally, these closures have been used to stockpile marine resources for feasts associated with social and cultural activities including funerals and festivals. However, with the exception of a no-take area established by a clan in Tsoilik, there was no indication of this occurring or having occurred in the living memories of respondents.

⁹ Interestingly, some respondent from Tsoilik, Mamion and Kuliban indicated minimum mesh size restrictions despite the absence of co-management arrangements. However, there was no consensus on what the minimum mesh sizes were.

Fishing restrictions relating to pregnant women were however recorded in all communities surveyed. Most responses suggested that pregnant women were not allowed to engage in fishing of all kinds though some respondents indicated prohibitions on certain types of fishing, the use of specific gears (including canoes and spears) and fishing at night. In some cases, these restrictions extended to husbands of pregnant women, newly married men and menstruating women. Reasons for these restrictions varied between community, rule and respondent though the most common ones were beliefs that fish would be scared away, not taste good, bring bad luck, and cause childbirth complications. These customary rules appear to be largely upheld and practised in the Tsoi Islands, but less so in the Tigak Islands and Patitab.

3.5.3 Attitudes to Marine Resource Health

Household survey respondents were asked whether or not they agreed with five attitude statements regarding the importance of maintaining healthy marine ecosystems to meet human needs (Table 7). Responses overwhelmingly indicate positive attitudes to all five statements.

Table 7. Aggregated responses to attitude statements depicting respondent's perceptions of the importance of healthy marine resources

Attitude Statement	Agree (%)	Disagree (%)	Unsure (%)
As the number of people who go fishing is increasing, it is becoming more important to manage fisheries to make sure we have enough to catch in the future	94.0	3.3	2.7
It is important that all community members look after the reefs	97.3	1.2	1.5
My family's health and well-being is linked to the health of our marine habitats	98.2	1.2	0.6
It is an important part of our culture to have a healthy marine environment	98.8	0.9	0.3
It doesn't matter what happens to our marine environment	5.5	91.5	3.0

When responses to all statements are aggregated at the community level, there are no clear attitudinal differences between villages (Figure19).

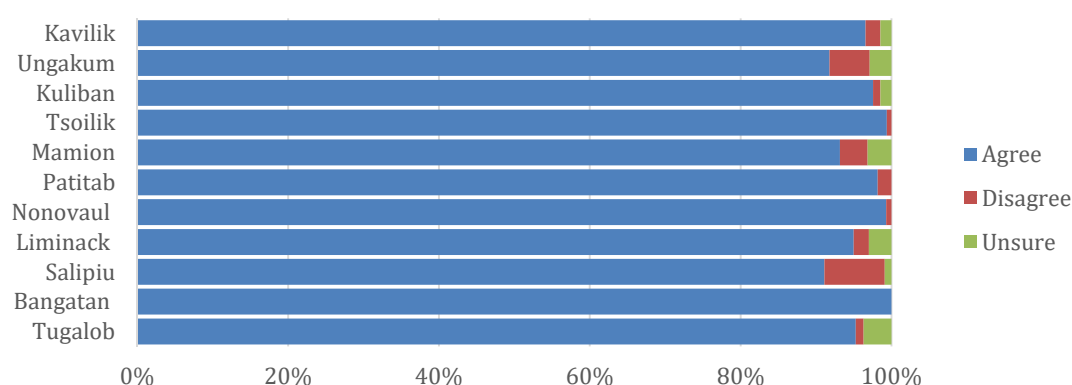


Figure 19. Responses to attitude statements disaggregated by village

3.5.4 Marine Resource Knowledge (Human Agency)

Household survey respondents were asked seven true/false questions concerning awareness about human impacts on the marine environment (Table 8). For each statement, aggregated responses reveal differences in the understanding of different fisheries impacts and the effectiveness of different management measures. Almost all respondents thought that protected areas could help restore ailing populations of marine animals whilst considerably fewer people thought that breaking corals and using fine mesh gillnets could be damaging. Two statements (1 and 6) designed to measure knowledge of the link between enabling marine animals to spawn and healthy populations were both answered well (>90%).

The results are a likely reflection of the type of management and awareness activities that have been undertaken by NGOs and the New Ireland Provincial Fisheries Office over the years. For example, the almost unanimous endorsement of protected areas is probably a result of permanent closures (tambu reefs) that have been established in five of the eleven communities interviewed.

Table 8. Aggregated responses to knowledge statements concerning the role of fishing activities on marine resource health

Knowledge Statements	True (%)	False (%)	Unsure (%)
1. Harvesting fish before they are sexually mature will make their numbers decrease	90.1	4.2	5.7
2. Fishing practices in neighbouring communities can have an impact on the number of fish in your community	88.9	3.9	7.2
3. Protected areas can help increase the numbers and size of some marine animals	97.6	0.6	1.8
4. Breaking corals to catch octopus is not destructive to the reef	22.1	73.1	4.8
5. Using small mesh gillnets is not destructive to local fisheries	24.9	70.3	4.8
6. Harvesting crabs and lobsters that are carrying eggs will not harm the population of these animals	6.0	91.3	2.7
7. Most types of fishing do not have an impact on the health of our fisheries	21.7	70.8	7.5

When responses to all statements are collapsed at the community level, we see different response patterns among villages and island groups (Figure 18). Most noticeably, there was only a small proportion of 'wrong' answers (3.5-5.6%) given by respondents from Tsoilik, Kuliban, Ungakum and Kavulik – all Tsoi Island communities. While the results for Ungakum and Kavulik may be explained by fisheries awareness activities undertaken by WCS over the years, the results for Tsoilik and Kuliban are less easily explained. The highest level of 'wrong' answers (and by inference lower awareness of human agency in fisheries health) was observed for Tugalob, Salipiu and Liminack.

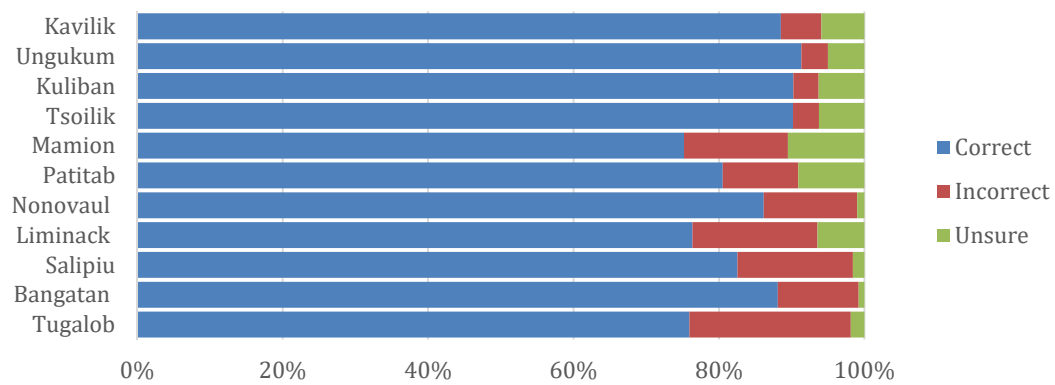


Figure 18. Responses to knowledge statements disaggregated by village

4 DISCUSSION

While the data presented in this report will serve as a valuable baseline reference of demographic and socioeconomic profiles benchmarked at the time of survey, the discussion will focus on Objective Two – to inform the development and implementation of fisheries management rules. Accordingly, recommendations will be provided where appropriate. Given the large proportion of households interviewed in each village, we are confident that the data collected is largely representational and reflective of prevailing socioeconomic conditions. However, results informed by the collection of weekly household fishing activity and income data will need to be viewed in light of the temporal variability that may affect this data.

4.1 Demographics

While the demographic data collected during this survey will serve as valuable baseline information, there are also results with direct implications for the development and implementation of fisheries management. Firstly, very high rates of population growth in Tsoilik, Mamion, Kuliban, Ungakum and Kavulik will continue to place additional pressures on marine resources, which may necessitate frequent adaptive management changes which will need to be informed by additional data collection. Given the lack of space and arable land in four of these communities (ex Ungakum), there are clear implications for sustainable population and family planning awareness programs.

Mean household incomes for all communities were low (range: PGK 8-284), especially in the Tsoi Islands and Patitab. When coupled with growing cash needs and limited income opportunities, it appears likely that the low incomes will place increasing pressures on marine resources to provide additional income (especially for high value species) and offset rising food costs. Low incomes also indicate that costs associated with fisheries rules, such as those requiring gear changes, will be difficult to absorb by fishers. As such, such costs may need to be subsidised by management partners.

While there were clear differences between Tigak and Tsoi Islands, clan constituency was very similar within the Tigak Islands and within the Tsoi Islands. Given informally recognised reciprocal fishing access rights based on mutual clan identification, the results have pertinent implications for fisheries management. Put simply, fishers are not restricted from fishing neighbouring waters and are more likely to do so if the targeted resources are less available in waters surrounding their own village. Management design, implementation and administration need to acknowledge and account for this. Most importantly, 'outsiders' need to comply with management rules when fishing in neighbouring waters, which may necessitate expanding awareness efforts to surrounding communities. Another way is to encourage inter-village management cooperation by scaling-up management units to encompass multiple villages. As well as encouraging a more consistent approach (and attitude) to fisheries management (especially if the same rules are introduced), management 'clusters' facilitate a collaborative multi-lateral approach to fisheries problems and solutions.

4.2 Fishing Activities

Finfish were targeted on almost three quarters of fishing trips undertaken, with the remaining trips targeting crustaceans and shellfish. The latter fisheries were more prominent for mangrove-associated communities who regularly harvest mud crabs and shellfish. While there was considerable variability in the total number of weekly trips undertaken across communities, temporal variations in fishing activities (seasonal, lunar and occasional) may have influenced the results. Despite this, the relative proportions of trips targeting the three broad fisheries within and

across communities are consistent with concurrent research undertaken by WCS through focus groups and fishing catch and effort surveys.

Reported temporal variations in fishing activity have important implications for fisheries management and future research/monitoring activities. For instance, fewer fisheries data may be collected if sampling is undertaken from December to March. The uniform reporting of heightened fishing activity during new and full moon periods (to coincide with fish spawning) is likely to pose challenges to management initiatives designed to reduce fishing pressure on spawning fish. For example, periodic closures of spawning sites during spawning periods will probably require a temporal and/or spatial transfer of fishing effort which may result in reduced catches, particularly in the short to medium term during stock recovery. Given the high dependence on marine resources, alternative fishing/livelihood options such as FAD deployment may need to be considered to meet village needs and encourage rule compliance.

The survey also showed that the bulk of fishing effort targeting crustaceans and shellfish, plus a considerable proportion of finfishing effort was undertaken by women. This underscores the need for a workable understanding of local gender dimensions as they relate to fishing and resource management when undertaking co-management activities with villages. For example, women are often marginalised in the decision-making process in Melanesia. As such, decision-making processes involved in developing and implementing management need to facilitate the inclusion of women. Without this balance, management arrangements may not reflect the will or capacity of women to comply with them. To this end, the representation of women in village marine management committees proportional to their role in the fishery should be encouraged, within the confines of cultural frameworks as they pertain to gender roles.

Knowing what fishing gears are owned by communities provides a better understanding of their capacity to adapt to new management rules, especially if they necessitate a transfer of fishing effort across gear types. Such knowledge will also inform limitations to the type of rules and strategies than can be effectively implemented. For example, encouraging a fishing effort transfer from inshore to offshore or deep-water fisheries will be difficult if there is low ownership of gear such as motor boats and/or high capacity winches/reels, which was evident in the survey. Knowledge of gear ownership can also help identify destructive fishing gears such as fine meshed gillnets and inform efforts to control their use.

4.3 Marine Resource Dependency

Dependency on marine resources is a measure of how dependent households are on local resources for food security and income needs and is generally closely linked to fishing pressure (Kronen *et al.*, 2010). Highly dependent communities are particularly vulnerable to perturbations in fishery health, including those associated with fishing pressure and climate change. They are also more vulnerable to restrictions imposed through fisheries management initiatives that result in decreased catch rates.

A range of measures were used to evaluate marine resource dependency, with some notable differences between island groups (i.e. Tigak and Tsoi Islands) and communities. All communities were highly dependent on locally caught seafood for subsistence consumption. However, for income generation, Tigak communities were more dependent on artisanal fishing as expressed by the proportion of seafood based primary occupations and the contribution of seafood based income to total household income. In view of higher average weekly household incomes for Tigak island communities, the results contradict those of a broader level study on western Pacific island communities whereby household incomes decreased with an increase in economic dependence on

artisanal fishing (Kronen *et al.*, 2010). The reason for the discrepancy is unclear but may relate to low incomes from non-fishing occupations and lower prices obtained for seafood in Lavongai-based markets accessed by Tsoi Island villages.

Despite the general inter-island group trends described above, a lower proportion of seafood based occupations were recorded in Salipiu and Ungakum, where communities had the space and soil quality to sell and trade surplus garden produce. While this will somewhat insulate livelihoods in these communities from decreased catch rates, their weekly protein consumption suggests they are still dependent on locally favourable marine resource conditions for catching, buying and trading for seafood.

The high marine resource dependence of all surveyed communities suggests that management measures that constrain catches will make it increasingly difficult to meet basic food and cash needs. This further suggests a role for livelihood diversification in maximising socioeconomic and sustainable fisheries objectives. In the short term, maintaining catches through FAD deployment has demonstrated potential in some western Pacific studies (Albert *et al.*, 2014; Cabral *et al.*, 2014). Low technology aquaculture may also provide benefits in this regard (Shelley, 2008). Beyond this, other measures should be considered though they are likely to be constrained by geographic remoteness, limited economic opportunities and institutional support, and low education levels.

4.4 Factors influencing the capacity and willingness of communities to undertake and comply with fisheries management

Fisheries management measures are only effective if they are readily adopted and therefore need to blend into the local socio-economic, socio-ecological and cultural context. As such, we attempted to understand some of the factors that define these contexts in an effort to develop management tools that are workable and able to be complied with. Information provided by key informants indicates that prevailing inter-access fishing arrangements by clan groups between communities will represent a challenge for effective management. Clearly, an inability or unwillingness to exclude outside fishers may compromise outcomes of management designed to produce local benefits from local actions. To address this, efforts could be undertaken to educate fishers about fishing rules implemented at neighbouring villages. In addition, scaling up management efforts at scales that reflect the movement of fishers within island groups (as discussed above) should be considered.

Some researchers have suggested that management measures for coastal fisheries in Melanesia need to reflect traditional management measures in order to be acceptable to coastal communities (Johannes 2002; Aswani *et al.*, 2012). Central to these studies have been the recognition of traditional no-take (tambu) zones, which has inspired recent co-management efforts in some areas. However, this study found limited evidence for this type of traditional management in the Tigak and Tsoi Islands. Nonetheless, knowledge and attitude surveys indicates a high level of acceptance of no-take zones among villagers, likely due to NGO co-management efforts over the last decade and limited use of small no-take zones by some clan groups. Despite this acceptance, the potential effectiveness of no-take zones in addressing fisheries objectives needs to be carefully considered in light of other management initiatives available.

Knowledge surveys also indicate a high level of awareness of the connection between allowing marine animals to spawn and the promotion of healthy fisheries. When coupled with the encouraging attitudinal results indicating a high level of concern for marine resource health, it is implied that management measures such as size-based harvest restrictions and spawning site closures may attract village support and cooperation, despite the absence of traditional management precedents. Exposure to awareness materials regarding national size limits on sea

cucumbers, trochus and rock lobsters may have contributed to these indications of support. Furthermore, results from management preference surveys conducted by WCS in all 11 communities also indicate encouraging levels of support for size based management and spawning site closures.

Key informant interviews in villages where management rules from co-management efforts have been implemented indicate the ineffectiveness of the Village Court system in addressing non-compliance. Clearly, future management efforts will need to address this by providing technical and logistical support to enable these institutions to facilitate effective management. Greater rule compliance may also be supported through on-going awareness efforts including the distribution of information such as summarised management rules translated in local languages and the repatriation of survey results by management partners. Based on the fisheries knowledge component of this survey, priority sites for imminent information support are Liminack, Salipiu and Tugalob.

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