MARKET SURVEY OF MANGROVE SHELLFISH FROM NORTHERN NEW IRELAND PROVINCE, PAPUA NEW GUINEA

AN ASSESSMENT OF SALES QUANTITIES, ECONOMIC IMPACTS AND HARVEST LOCATIONS OF FOUR SPECIES OF MANGROVE ASSOCIATED SHELLFISH SOLD AT THE KAVIENG MARKET, NEW IRELAND PROVINCE.

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INTRODUCTION

Artisanal fishing is typically associated with small-scale independent seafood harvesters using traditional low-technology fishing gear to supply seafood for local demands, both subsistence and commercial (generally at local markets). Artisanal fishers are further typified by harvesting seafood (which usually has limited processing) in coastal areas and may do so on a full-time, part-time or opportunistic basis. While artisanal fishing is practiced all over the world it is especially important in the coastal tropics due to high population densities in these areas and the reliance of many communities on natural resources as a source of income and food.

According to the FAO in 2002, about 135 million people were directly or indirectly employed worldwide in artisanal and small-scale fisheries and aquaculture (FAO, 2004[1]). While food security and health are clearly addressed though artisanal fishing, such activities also make substantial contributions to the economies of tropical coastal regions.

Despite rapid modernisation and commercialisation of many of the world's fisheries, artisanal shellfish harvesting remains an important cultural and traditional practice in many parts of the world including New Ireland Province in Papua New Guinea (PNG). Many coastal communities in northern New Ireland are situated close to mangrove forests which afford them coastal protection from storm surges, timber for building and firewood, traditional medicines, recreational opportunities and nursery habitats for important coral reef fisheries. There are also fisheries harvested directly from mangrove areas that provide communities with food and income. While mud crabs (*Scylla* spp.) are the most prominent fishery in this regard, other fisheries including shellfishes are also presumed to be important contributors to local livelihoods for mangrove associated communities. However, to date, there have been no PNG based studies to determine just how these fisheries contribute to local economic well-being or nutrition. Also, there are currently no management arrangements in place for any mangrove associated fisheries in New Ireland Province. In view of this, the Wildlife Conservation Society (WCS) conducted a market survey at the Kavieng main market to better understand the economic importance to local artisanal fishers of mangrove associated shellfish fisheries in northern New Ireland Province. Following initial surveys in the market to identify the principal species for sale, four species were investigated in detail: *Polymesoda erosa* and *P. geloin* (mud clams), *Anadara granosa* (blood cockle) and *Terebralia palustris* (mud creeper)[2]. In the absence of other information, it is hoped that the results of this study will serve as a baseline of economic and, to some degree, ecological conditions underpinning the fishery.

OBJECTIVES

The main objective of this report is to assess the annual economic value of the artisanal mangrove-associated shellfisheries in northern New Ireland Province. Secondary objectives are to gain a better understanding of the relative contributions of different communities, harvest site and shellfish species.

METHODS

[1] FAO. *The state of world fisheries and aquaculture*. Rome: United Nations Fisheries and Agriculture Organization (2004).

[2] The species are comprehensively described in the literature review produced in conjunction with this report.

The survey was conducted through semi-structured interviews with vendors at the Kavieng market. The survey questionnaire and sampling strategy was informed by preliminary visits to the market to identify the species of shellfish sold[3], retail prices, presentation styles and the number of vendors on different days of the week and from a pilot survey of five vendors to identify adjustments to the questionnaire form. See appendix 1 for survey instrument.

Questionnaire Development

The questionnaire was developed to collect the following information

- Location of harvest sites
- Home communities of vendors
- Quantity of shellfish available to be sold
- Quantity of shellfish sold prior to interview
- Retail prices

Sampling Strategy

A series of preliminary market visits indicated that Saturdays attracted the greatest number of shellfish vendors while there was little difference in the number of vendors on weekdays (the market does not operate on Sundays and Mondays). Accordingly, interviews were conducted every second Saturday morning and a randomly selected weekday every second week. The survey began on November 8, 2014 and ended on June 20, 2015. Surveys were undertaken on a total of 29 days - 15 Saturdays and 14 weekdays.

Before the survey commenced, information sheets were distributed among shellfish vendors during preliminary visits explaining the purpose of the upcoming survey and confidentiality protocols preventing the disclosure of personally identifying information in survey outputs. During the survey period, all vendors selling mangrove associated shellfish were approached at the Kavieng market and asked for their participation. If approached for the first time, vendors were also asked if they were familiar with the survey – if not, the purpose of the survey was explained and they were given an information sheet. Vendors were paid PGK 2.00 for each interview (around US$ 0.65 at the time of the survey) to encourage participation and as a goodwill gesture to encourage ongoing participation over the survey period.

RESULTS

Communities and Harvesting Grounds

Nineteen communities were represented during the survey, spanning three subregions of northern New Ireland – mainland New Ireland, the Tigak Islands and the Tsoi Islands. While vendors generally sold shellfish from mangroves close to their community, there were some exceptions whereby vendors accessed shellfish from mangrove systems further afield, through inter-community access

[3] Small quantities of one species of mangrove oyster were also identified at the Kavieng market during the latter stages of the survey which were not canvassed during data collection. From conversations with vendors, it is understood that this species had began to be supplied to the market to meet demands from the local Chinese community.

arrangements. The relationship between communities and mangroves (fishing grounds) is shown in Table 1 while the location of represented communities is shown in Figure 1.

Figure 1. Distribution of communities supplying the four studied shellfish species to the Kavieng market

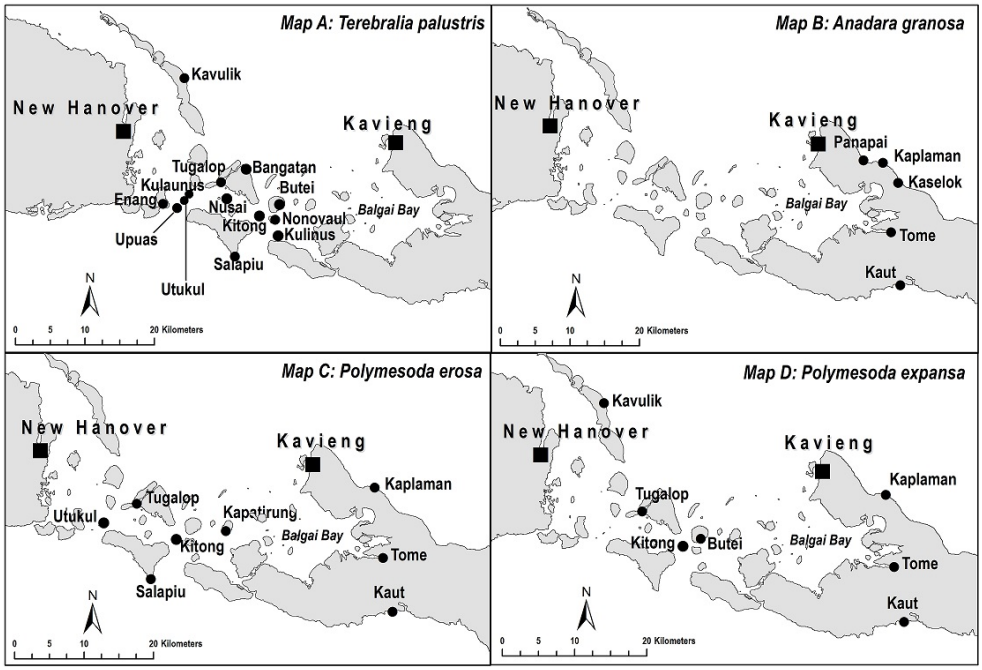


Table 1. Communities and harvest sites for each of the four studied shellfish species

Region	Community	Fishing ground			
		A. granosa	***P. erosa***	***P. geloin***	***T. palustris***
Mainland (M)	Kaplaman	Kaplaman (Balgai bay)	Kaplaman	Kaplaman	-
Mainland (M)	Kaselok	Kaplaman (Balgai bay)	-	-	-
Mainland (M)	Kaut	Kaut	Kaut	Kaut	-
Mainland (M)	Panapai	Kaplaman (Balgai Bay)	-	-	-
Mainland (M)	Tome	Tome (Balgai bay)	Tome	Tome	-
Tigak (Ti)	Bangatan	-	-	-	Bangatan
Tigak (Ti)	Butei	-	-	Butei	Butei
Tigak (Ti)	Enang	-	-	-	Enang
Tigak (Ti)	Kapatirung	-	Kapatirung	-	-
Tigak (Ti)	Kitong	-	Kitong	Kitong	Kitong
Tigak (Ti)	Kulaunus	-	-	-	Kulaunus
Tigak (Ti)	Kulinus	-	-	-	Ngup
Tigak (Ti)	Nonovaul	-	-	-	Nonovaul
Tigak (Ti)	Nusai	-	-	-	Nusai
Tigak (Ti)	Salapiu	-	Salapiu		Salapiu
Tigak (Ti)	Tugalop	-	Tugalop	Tugalop	Tugalop
Tigak (Ti)	Upuas	-	-	-	Petei
Tigak (Ti)	Utukul	-	Petei	-	Petei
Tsoi (Ts)	Kavulik	-	-	-	Kavulik

Across the three regions and 19 communities, 16 fishing grounds were identified (Table 1). Fourteen communities' harvested shellfish from their own community fishing grounds while five communities harvested from fishing grounds aligned to other communities. For instance, Utukul and Upuas harvested shellfish from Petei mangroves, while Kulinus harvested shellfish from Ngup mangrove system.

Shellfish Sold and Units of Sale

The four shellfish species (Figure 2) were sold either fresh or cooked on skewers. The unit of sale and other relevant information for each species are described on the following pages.

Figure 2. Images of the four main shellfish species investigated in this study. Top left *Andara granosa*; top right *Polymesoda erosa*; bottom left *Polymesoda geloin*; bottom right *Terebralia palustris*. All images WCS apart from *Terebralia palustris*[4]

[4] Image downloaded from: http://www.safari-afrika.de/html/terebralia_palustris.html

Blood Cockle (Andara granosa)

Anadara granosa, known locally as the "blood cockle", were supplied only by mainland New Ireland communities accessing the Balgai Bay mangrove system. The marine bivalve was sold cooked and threaded on skewers and as fresh product in heaps (piles on the ground), baskets (made from coconut leaves) and bags (10kg rice bags). The average number of shellfish sold in each sale 'unit' was 14 (skewers), 50 (fresh product), 100 (coconut baskets), and 250 (bags). It was observed that vendors who sold *A. granosa* did not sell other products, compared to other shellfish vendors who sold shellfish in addition to other goods.

Mud Clam (Polymesoda erosa)

Polymesoda erosa, called mud clams in New Ireland, were supplied by eight communities; three from mainland New Ireland and five from the Tigak Islands (Figure 1). Like *Andara granosa,* this large bivalve was sold threaded on cooked skewers and as fresh produce in heaps, baskets and bags. The average number of shellfish sold in each sale 'unit' was 11 (skewers), 7 (fresh produce), 45 (baskets) and 29 (bags).

Mud Clam (Polymesoda geloin)

Polymesoda geloin, which is also known as the mud clam by local communities, was supplied in relatively small quantities by six communities – three each from mainland New Ireland and the Tigak Islands. (Figure 1). As for *Anadara granosa* and *Polymesoda erosa*, this bivalve was also sold threaded on cooked skewers and as fresh products in heaps, baskets and bags. On average, the number of shellfish sold in each sale 'unit' was 13 (skewers), 16 (fresh product), 50 (baskets) and 35 (heaps) respectively. Sellers of *P. geloin* generally sold other produce including coconuts, firewood, uncooked sago and vegetables.

Mud Creeper (Terebralia palustris)

Terebralia palustris, which is locally called mud creeper in New Ireland, was sold by vendors from 12 Tigak Island communities and one community from the Tsoi Islands (Kavulik). Unlike the three bivalve species, this gastropod was only sold threaded on cooked skewers with an average of 20 per skewer. Sellers of *T. palustris* generally also sold smoked fish, and sometimes cooked sago.

Sales by Shellfish Numbers

In terms of overall shellfish numbers, 63.4% of shellfish sold on sampling days were *A. granosa* followed by *T. palustris* (25.6%), *P. geloin* (4.8%) and *P. erosa* (4.7%) (Table 2). Average total numbers counted (including pre-sold shellfish) on sampling days for the four species were 88,192 (*A. granosai*), 33,600 (*T. palustris*), 6,232 (*P. geloin*) and 6,115 (*P. erosa*).

Overall, 72% of shellfish brought to the market were cooked (i.e. on skewers) while 28% were fresh (i.e. in heaps [12%], baskets [9%] and bags [7%]). Figure 3 displays the relative volumes of each species brought to the Kavieng market in terms of being either cooked or fresh. Approximately 90% of all shellfish sales comprised cooked *A. granosa* (42%), cooked *T. palustris* (27%) and fresh *A.*

Table 2 Summary data of total shellfish numbers sold on sampling days

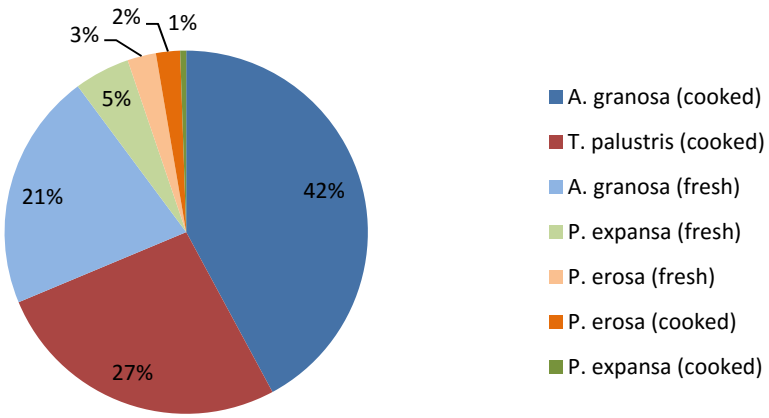
Species	Cooked			Heaps			Baskets			Bags			Total # of SF sold	% of total SF sold
	Mean # SF p/skewer	# units sold	Total # of SF sold	Mean # SF p/heap	# units sold	Total # of SF sold	Mean # SF p/basket	# units sold	Total # SF sold	Mean # SF p/bag	# units sold	Total # SF sold		
A. granosa	14	4,078	57,092	50	221	11,050	100	88	8,800	250	33	8,250	**85,192**	**63.4**
P. erosa	11	255	2,805	7	156	1,092	45	48	2,160	29	2	58	**6,115**	**4.7**
P. expansa	13	53	689	16	278	4,448	50	17	850	35	7	245	**6,232**	**4.8**
T. palustris	20	1,680	33,600	0	0	0	0	0	0	0	0	0	**33,600**	**25.6**
Total		**6,066**	**94,186**	**73**	**655**	**16,590**	**195**	**153**	**11,810**	**314**	**42**	**8,553**	**131,139**	**100**

Table 3. Summary of sampling particulars for both Saturdays and weekdays

Species	Saturdays												
	Mean # of vendors	% of days selling	Mean # of SF sold (skewers)	% of days selling	Mean # of SF sold (heaps)	% of days selling	Mean # of SF sold (baskets)	% of days selling	Mean # of SF sold (bags)	% of days selling	**Mean # of SF sold (total)**	**% of SF sold (total)**	**Mean # of SF sold p/vendor**
A. granosa	5.5	100	3251	94	683	63	473	25	383	44	**4790**	**68.5**	**871**
P. erosa	1.6	81	98	38	51	50	113	48	4	6	**266**	**3.8**	**166**
P. expansa	2	75	30	6	229	69	47	25	12	13	**318**	**4.5**	**159**
T. Palustis	4.9	62	1616	63	_	_	_	_	_	_	**1616**	**23.1**	**330**
	Weekdays												
A. granosa	1.3	62	595	54	57	8	121	14	_	_	**773**	**44.2**	**595**
P. erosa	0.8	54	88	39	20	23	26	8	_	_	**134**	**7.7**	**168**
P. expansa	0.7	62	18	15	67	41	11	8	_	_	**96**	**5.5**	**137**
T. Palustis	2.2	69	744	69	_	_	_	_	_	_	**744**	**42.6**	**744**

granosa (21%). Cooked and fresh *P. geloin* and *P. erosa* comprised approximately 10% of sales by shellfish number.

Figure 3. Composition of shellfish species and presentation styles on counted on sampling dates



Saturdays and Weekdays

Overall, the ratio of the mean numbers of shellfish sold on Saturdays (6,990) and weekdays (1,747) was 4:1 (Table 3). By species, the ratios were: *A. granosa* (6.2:1); *P. erosa* (2:1), *P. geloin* (3.3:1); *T. palustris* (2.2:1).

There were considerable differences in the relative proportions of shellfish species sold between Saturdays and weekdays. Most prominently, *A. granosa* comprised 68.5% and 44.2% of total sales on Saturdays and weekdays while the respective amounts for *T. palustris* were 23.1% and 42.6%.

The respective mean number of shellfish vendors on Saturdays and weekdays was 13.9 and 5.0[5] and the average number of vendors for all species was higher on Saturdays than on weekdays. For each species, vendors were present on more than 50% of Saturdays and weekdays (range: 54-100%). For *A. granosa*, *P. geloin* and *P. erosa*, vendors were present on a greater proportion of Saturdays than weekdays. However, for *T. palustris*, vendors were present on 62% of Saturdays and 69% of weekdays, despite the respective average number of vendors for this species being 4.9 and 2.2.

Annual Shellfish Sales by Community

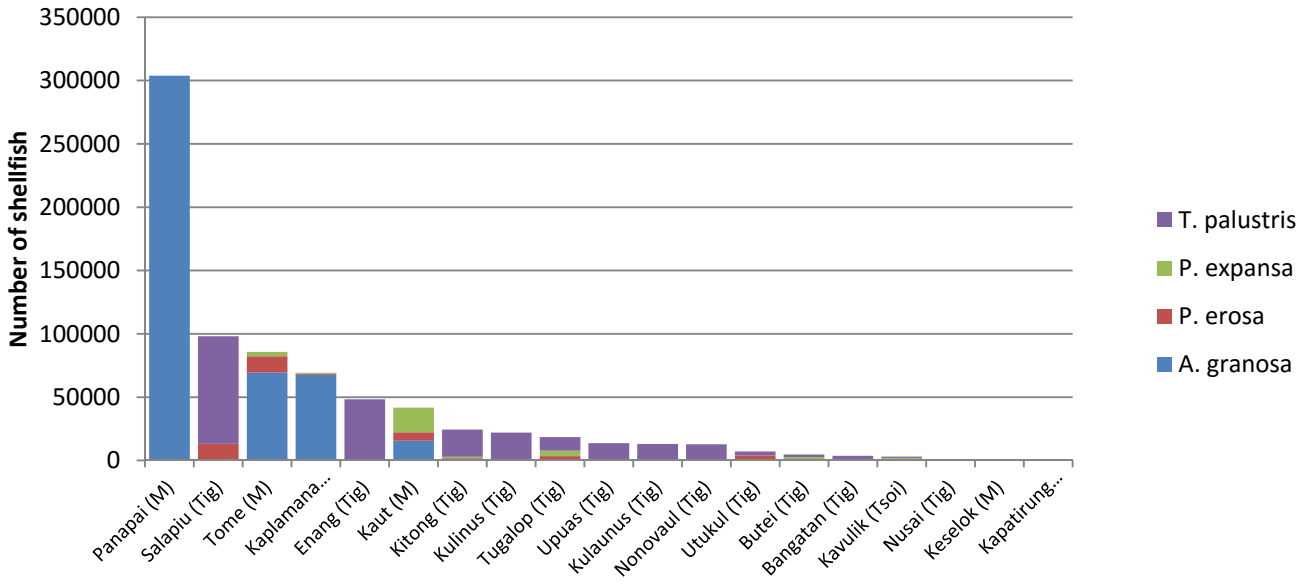
By extrapolating survey data, an estimated 772,000 shellfish are sold through the Kavieng market annually. By species, annual estimates are: *A. granosa,* 457,000 (59%); *T. palustris*, 237,000 (31%); *P. erosa* 43,200 (6%); and *P. geloin*, 34,150 (4%).

[5] Some vendors sold more than one shellfish species. As such these values may overestimate the average number of shellfish vendors

By community, annual estimates are highly skewed (Figure 4). Among the 19 communities represented, it was estimated that five communities – three from mainland New Ireland and two from the Tigak Islands – supply around 78% of all shellfish. Among these communities, an estimated 39.3% of total annual shellfish (all *A. granosa*) sold at the Kavieng market was sold by residents of Panapai. The seven communities that were least represented in the survey contributed less than 3% of total shellfish numbers sold.

Andara granosa, which constituted almost 60% of annual shellfish sales by number, was sold by residents of only four communities – Panapai, Tome, Kaplaman and Kaut – all of which are located on mainland New Ireland and access fishing grounds in Balgai Bay. The shellfish species sold by the greatest number of communities (13) was *T. paulstris*, though 36% was supplied by only one community – Salapiu. The number of communities selling *P. erosa* and *P. geloin* was seven and eight, respectively.

Figure 4. Estimated annual numbers of mangrove shellfish sold at the Kavieng market by 19 communities in northern New Ireland

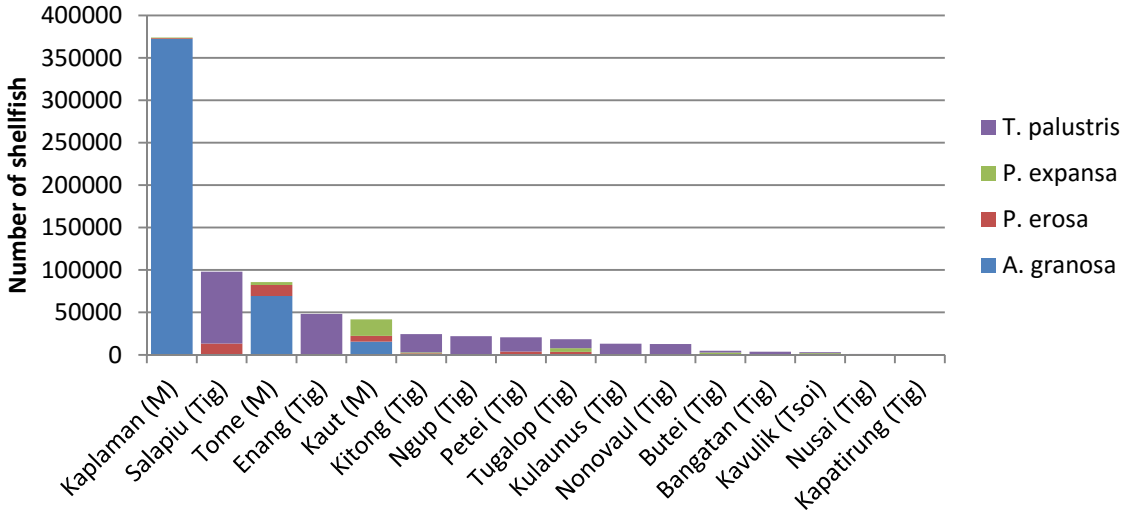


Annual Shellfish Sales by Harvest Site

By harvest site, annual estimates were also highly skewed with five sites providing around 85% of total annual shellfish production. Most prominently, approximately 48% of total shellfish numbers were harvested from Kaplaman in Balgai Bay, mainland New Ireland. The communities of Panapai, Kaplaman and Kaselok access this site which produces around 85% of *A. granosa* supplied to the Kavieng market. Among the 16 fishing grounds identified in the survey, less than 2% of shellfish sold through the market were harvested from five fishing grounds – Butei, Bangatan, Kavulik, Nusai and Kapatirung.

Andara granosa were harvested from only three harvesting sites – Kaplaman, Tome and Kaut – all of which are located within the extensive Balgai Bay mangrove system on mainland New Ireland. Conversely, *T. palustris* were not harvested from any mainland sites but were harvested from all sites on the Tigak and Tsoi Islands, with the exception of Kapatirung. *Polymesoda erosa* and *P. geloin* were harvested from eight sites each across both mainland and island mangroves, four of which were shared. However, quantities brought to market were low compared with quantities of *A. granosa* and *T. palustris*.

Figure 5. Estimated annual numbers of mangrove shellfish sold at the Kavieng market from 16 harvest sites in northern New Ireland

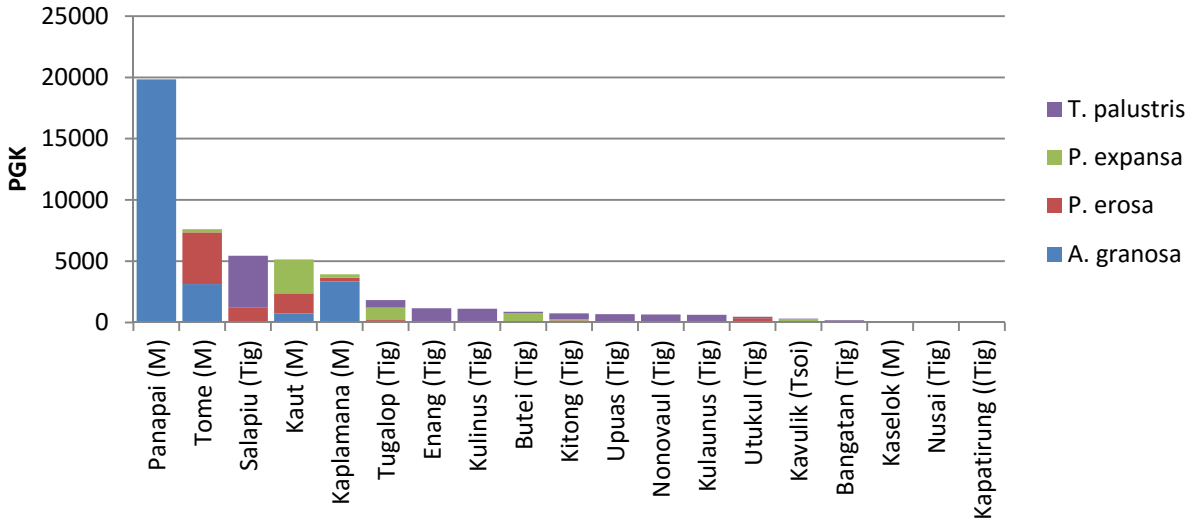


Economic Impact

By multiplying average unit costs by the number of (extrapolated) units sold, annual estimates of the economic impact attributed to shellfish species and individual communities can be derived. Overall, annual sales at the Kavieng market exceed PGK 50,000 (around US$16,000). The relative contributions of the four shellfish species to estimated annual sales and a percentage of sales are: *A. granosa* (PGK 27,140: 54%), *T. palustris* (PGK 10,050: 20%), *P. erosa* (PGK 8,150: 16%) and *P. geloin* (PGK 4,900: 10%). While the two *Polymesoda* species yielded the lowest total annual estimated sales values, their contribution to overall sales was considerably greater than their contribution to total harvest numbers owing to the greater sales prices for these species.

By community, annual sales for Panapai are estimated to be around PGK 20,000. The next four highest estimated sales values are for Tome (PGK 7,610), Salapiu (PGK 7,440), Kaut (PGK 5,140) and Kaplaman (PGK 3,930). Sales for the four communities with the lowest sales values totalled only PGK 400.

Figure 6. Estimated annual sales of mangrove shellfish sold at the Kavieng market by 19 communities in northern New Ireland



CONCLUSIONS

A summary of results is provided below:

- Data collected for this study indicates that approximately 770,000 mangrove-associated shellfish are sold at the Kavieng market annually, with an estimated sales value of PGK 50,000.
- While *P. mesoda*, *P. geloin* and *T. palustris* are widespread throughout northern New Ireland province, *A. granosa* was only sourced from sites within the Balgai Bay mangrove system on mainland New Ireland.
- In terms of numbers of shellfish sold, the relative annual contributions of the four species of shellfish sold were: *A. granosa* (59%); *T. palustris* (31%); *P. erosa* (6%); and *P. geloin* (4%).
- In terms of annual sales, the relative economic contributions of the four species were: *A. granosa* (54%); *T. palustris* (20%); *P. erosa* (16%); and *P. geloin* (10%).
- By community, annual estimates of total shellfish numbers sold are highly skewed: five of the 19 communities represented (Panapai, Salipiu, Tome, Kapalaman and Enang) supplied around 78% of shellfish sold at the market annually.
- By harvest site, annual estimates of total shellfish numbers sold were also highly skewed with five mangrove sites (Kaplaman, Salipiu, Tome, Enang and Kaut) providing around 85% of total annual shellfish production

- Approximately 65% of total shellfish numbers brought to Kavieng market annually are harvested from Balgai Bay

The results indicate that mangroves in New Ireland provide income opportunities to artisanal harvesters, particularly from mainland-based communities that harvest shellfish from Balgai Bay. Sales data from communities providing small volumes of shellfish to the market likely reflects a situation whereby shellfish are harvested on an opportunistic basis enabling villagers to obtain money when required rather than a reflection of the shellfish available to be harvested. The low prices paid for shellfish (compared to say mud crabs) and the travel costs associated with accessing the market from the Tigak and Tsoi Islands supports this assertion. As such, the results from this study should not be used to infer the relative health of shellfisheries at different mangrove sites. Similarly, it is difficult to infer spatial patterns of harvesting pressure without a detailed understanding of the volumes of shellfish harvested for subsistence consumption across mangrove sites. Nonetheless, concurrent fishing catch and effort surveys conducted by WCS indicates a considerable level of village-level consumption at Tigak and Tsoi Island survey sites, some of which are the same sites recorded in this report (Kavulik, Bangatan, Tugalob, Nonovaul and Salipiu)

Despite these knowledge gaps, this study and other work currently conducted by WCS confirms the importance of mangrove associated shellfisheries in providing livelihood opportunities and food security in New Ireland. As such, future work needs to assess the vulnerability of these fisheries, and if necessary, implement measures to safeguard their importance for artisanal fishers. In particular, future research could provide a better understanding of the role mangrove shellfisheries play in insulating village communities during times of food shortage, including monsoon seasons when unfavourable sea conditions limit the harvest of non-mangrove seafood.