
A Review of Fisheries and Marine Resources in New Ireland Province, Papua New Guinea



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INTRODUCTION

The purpose of this review is to review the fisheries and marine resources of New Ireland Province. It identifies existing marine resources (both commercial and non-commercial), describes the dynamics of each fishery, and outlines management guidelines that govern the various fisheries. This review also presents current monitoring initiatives undertaken in the province by non-governmental organisations.

The province

New Ireland Province is situated between 2°30' and 4°30' S latitude and 150°40' and 153°10' E longitude (Wright et al., 1983) and is the second largest island in the Bismarck Archipelago. Offshore islands that make up the province include New Hanover, the Tigak Islands, Djaul (including Mait Island), the St. Mathias Group (Tench, Emirau and Mussau), Tabar, Lihir, Tanga and Anir islands (Fig.1).

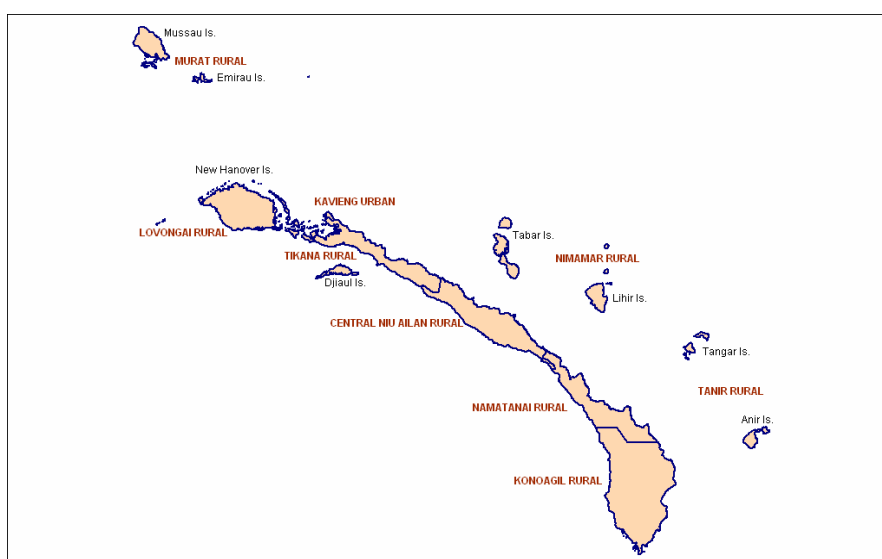


Figure 1: New Ireland Province and its outer island groups

Parts of New Ireland's coastline are marked by fringing and scattered patch reefs, with some reef flats extending seaward to about 200 m, some of which slope gently downward into deeper water. On the west coast of New Ireland, the southern end of the island, and parts of the offshore islands, the reef flats are much narrower (50 m in some areas), sloping steeply downward into deeper water. Other areas have even narrower fringing reef flats with very steep drop-offs.

Wright and Richards (1983) estimated the provincial reef area that is less than 30 m deep to be 139,000 ha, while Munro (1976) estimated the shelf area (less than 200 m deep) to be 446,000 ha.

The province has a total land area of 9,600 km² spread over a sea area of 230,000 km². Its total shoreline length is estimated to be 1,334 km. The current population of the province is 118,350, 62,760 of which are males and 55,590, females (National Statistics Office, 2000). Kavieng, the provincial capital, has a population of 11,274 (see Appendix 1 for population details).

About 20 different languages are spoken in New Ireland. However, the common language spoken throughout the province is Pidgin, although English is taught in the schools.

The main island of New Ireland has an airport in Kavieng and an airstrip at Namatanai (about half-way south of the island) and a road system that, in most parts, is negotiable only by a four-wheel-drive vehicle. Some of the main island groups have airstrips serviced by small planes, whereas most of the outer islands are accessible only by small vessels or fibreglass banana boats.

Fisheries and marine resources

Various fisheries and marine resources are harvested for subsistence, artisanal and commercial use. Coral reef finfish resources are a major source of protein for most coastal communities, and beche-de-mer is mainly sold to supplement household incomes. In other communities, coral finfish are either sold for cash or bartered for food crop items within communities.

Using an estimated reef area of 139,000 ha for New Ireland (Wright and Richards, 1983), and assuming an exploitation rate of 20 kg/ha/year, the fisheries potential for the reef area is estimated at 2,780 t. Munro (1976) estimated the fisheries potential for New Ireland for both the reef area and for the shelf area, at two different exploitation levels. The fisheries potential for the shelf area is 3,570 t, estimated for moderate exploitation (assuming 8 kg/ha/year) and 13,400 t for heavy exploitation (30 kg/ha/year).

New and better marketing opportunities, together with better purchase prices are resulting in women taking a more active role in both commercial and subsistence finfish fishing. (Women typically tend to concentrate their efforts on reef gleaning, and collecting edible bivalves and crabs from the reef flats and mangrove forests for subsistent purposes.) These opportunities are also incentives for men to become involved in harvesting mud crabs, a fishing activity typically dominated by women.

New Ireland has highly productive tuna fishing grounds that provide opportunities for the province to act as a base for large-scale commercial tuna developments; the positive economic returns also give a boost to the local economy. However, the greater involvement and participation in fisheries development by New Ireland people will be realised through the sustainable exploitation of nearshore resources.

Levels of exploitation vary from resource to resource and within individual resources. For instance, the beche-de-mer resource is currently undergoing heavy exploitation, while deepwater finfish resources are only lightly exploited. Baitfish resources that were once targeted in the 1980s for the pole-and-line tuna fleet are currently not being exploited at all. Within the fishery, localised overfishing of sandfish has occurred while in the coral food finfish fishery, mullet (*Valamugil seheli*) is no longer the major component of inshore finfish harvests.

The differences in the level of exploitation may be due to a number of factors including market driven opportunities, existing infrastructure developments, availability of new fishing gear and changing government policies. A new commercial fisheries wharf for large longliners and a jetty for smaller inshore banana boats were completed in 2004 with funding from an Asian Development Bank loan. An ice making machine and a modern fish processing plant were also built adjacent to the wharf and completed at the same time. These were funded by AusAID for the National Fisheries College.

One of the licensed fish buyer and exporters, Ailan Seafoods Limited (ASL), leases out the processing plant and manages the making and sale of ice. Under individual partnership agreements with a number of boat owners participating in the European Union-funded Rural Coastal Fisheries Development Project, the company purchases

all fish from these boats, processes the fish in the plant, and exports the fish to other parts of PNG or overseas. This company also set up a fish-buying point near the small jetty to buy fish and other marine products from other boats and canoes. The new infrastructure developments in Kavieng have greatly enhanced the potential for increasing income opportunities for fishermen.

Fish are also sold to various fish buyers in Kavieng town, including hotels, restaurants, fish and chips shops, and wholesale fish buyers and exporters.

There are five exporters in Kavieng, who export a variety of marine products, including trochus, beche-de-mer, crocodile skin, and whole or filleted fish. Some marine products however, leave the province and do not appear in the export figures for New Ireland. For example, products from the Namatanai area are sold to Rabaul and Kokopo markets in East New Britain Province.

A description and review of the fisheries and marine resources of New Ireland Province follows.

DEMERSAL DEEP-SEA FISH

Resource

Deep-sea fish resources are bottom or near-bottom dwelling finfish, and include snappers, emperors, jacks, cods and groupers that live in depths ranging from 80–360 m.

At least 100 deep-sea species have been recorded in the western and central Pacific, but only eight families are regularly caught in New Ireland (see App. 2). In Kavieng, 48 of these species were recorded (Wright et al., 1983).

Fishery

There is a small, relatively new deep-water fishery in New Ireland that is concentrated around the northern end of the island, mainly around Kavieng and the Emirau Islands. In the past, only small craft — mainly outrigger canoes — were used for fishing near the shore. Travelling farther offshore would have been risky, and thus the islanders did not tend to fish the deep-water stocks. Gear limitations may also have been a determining factor. Fishing for deep-water snappers was conducted at a subsistence level at Lavongai Village on New Hanover, and Mangai on the east coast of New Ireland. Local fisherman in outrigger canoes discovered the demersal finfish during the 1970s.

In the 1980s experimental fishing trials for deep-water species were conducted by the former Department of Fisheries and Marine Resources, Fisheries Research Branch, around Kavieng and Tigak Islands, New Hanover, Emirau and Tench Islands, Mussau, the Konoagil area at the southernmost tip of New Ireland, and Lihir. Trials were conducted using wire mesh traps, horizontal set longlines, and vertical set longlines.

Depending on where fishing was done, the dominant species caught were *Pristipomoides multidens* in depths ranging from 80–200 m; in deeper waters, the dominant species were *Etelis carbunculus*. Carangids, lethrinids and many serranids inhabit shallower (<120 m) waters, *Pristipomoides* and some serranids inhabit depths of 120–240 m, and *Etelis* spp. and some serranids inhabit waters greater than 240 m (Sunberg and Campbell, 1982; Richards and Tatamasi, 1984; Moffitt, 1993)

Overall, *P. multidens* was the dominant species in deep-slope fish catches in New Ireland. In 1992, 220 hours of fishing around Kavieng resulted in 600 fish caught with

a combined total weight of 2,215 t, *P. multidens* comprised 25.8% by weight (Fisheries Research 1982). In southern New Hanover, *P. multidens* dominated a catch of 141 fish — weighing 270.2 kg — both in weight (31.3%) and numbers (25.5%) during a 20-hour spread over three days of fishing trials (Aini, 1993)

Fishing for deep-water snapper on a large commercial scale in the province did not occur until 2004–2005 with the introduction of seven 8.2-m fibreglass dories with inboard diesel engines (Fig. 1), by the European Union-funded RCFDP (Kinch 2005). These boats are owned by either fishing groups or individual and who sell all their catch to ASL under Private Sector Partnership (PSP) agreements.



Figure 1: The new 8.2-m EU Rural Coastal Fisheries Development Project dories at the small boat jetty in Kavieng.

From October 2004–July 2005, the RCFDP fisher groups landed a total of 44,952.4 kg of fish of which, 19,455.7 kg or over 43% were deepwater red snappers (Table1). Of the deepwater snapper landings, the catch was predominantly *Etelis carbunculus*, *E. coruscans* and *Pristipomoides multidens*. *Etelis* spp. made up 43% and *Pristipomoides* spp. contributed 54% (Kinch, 2005).

Table 1: Total deep-water snapper landings (kg) at ASL by RCFDP vessels, October 2004–July 2005 (Source: Kinch, 2005)

Species	Amount (kg)	Percentage of red snappers
<i>Aprion/Aphareus</i> spp.	144.9	0.74%
<i>Etelis</i> spp.	8360.3	42.97%
<i>Lutjanus</i> spp.	448.5	2.31%
<i>Pristipomoides</i> spp.	10502.0	53.98%
Total deep-water snapper	19455.7	43.63%
Total all fish	44952.4	

Current status

There are now seven dories in the fishery with the eighth one about to be deployed. Under the PSP agreements all of the catch is sold to ASL where it is processed and either exported or sold domestically (Fig. 2). Catches made by the dories from October 2004–July 2005 are presented in Table 2.

**Table 2: Deep-water snapper landings (kg) by RCFDP vessels at ASL by month:
October 2004–July 2005 (Source: Kinch, 2005)**

Month	Vessel 1	Vessel 2	Vessel 3	Vessel 4	Vessel 5	Vessel 6	Vessel 7	Total
Oct-04	327.0	282.0			423.0		395.0	1427.0
Nov-04	304.0	612.0			748.0		807.0	2471.0
Dec-04	576.4	249.4			696.9		1269.2	2791.9
Jan-05	119.0	398.2			28.0		95.4	640.6
Feb-05	203.6	267.0			807.5		95.2	1373.3
Mar-05		87.0			273.0		922.6	1282.6
Apr-05		579.0			930.5		642.5	2152.0
May-05	557.2	1037.5			687.0		40.0	2321.7
Jun-05	177.3	333.0	89.0	221.0	674.8	173.5		1668.6
Jul-05	683.0	644.0	25.0	261.0	1011.0	140.0	563.0	3327.0
Total	2947.5	4489.1	114.0	482.0	6279.7	313.5	4829.9	19,455.7

Two other private fishing companies involved in the fishing for deepwater red snapper themselves as well purchasing from other fishermen. Altogether they make an estimated landing of 850 kg per month (Kinch, 2005).



Figure 2: Catches from the EU RCFDP dories being sorted at the ASL plant

On a smaller scale, Kavieng fishermen are involved in the fishery. Fishing is not always done full time but nearly always at the subsistent level driven by demand, when they need cash the fishermen go out to fish the more valuable deepwater and pelagic species and sell to supplement their income. There are only a few deepwater fishermen (mainly from Emirau Island living in Kavieng) who fish for income on a regular basis.

Deep-water fishing however is being developed gradually with better pricing and the availability of a market that consistently buys deep-water fish. A number of trainings on deep-water fishing, as well as post-harvest training carried out by NFC with assistance from the Secretariat of the Pacific Community (SPC) has further contributed to the development of the fishery. Over 50 people have been trained (Sokimi and Chapman, 2001), although not all of them are involved in deep-sea fishing at this stage.

Most deep-water fisherman use fibreglass banana boats (powered by 40 hp Yamaha outboards) for fishing (Fig. 3). Some fishermen have also bought new fishing gears and eskies. According to these fishermen, this has enabled them to take enough ice, process bigger catches, and stay at sea for longer periods.



Figure 3: One of the banana boats typically laid out for deep snapper fishing with two Samoan hand-reels and an ice box.

A number of studies have been done by SPC and PNG fisheries research programme on the catch rate for deep-water red snapper in New Ireland Province. Some of the results published are listed in Table 3.

Table 3: Catch rates in average weight per reel hour for deepwater fishing in New Ireland

Location	Average catch rates (kg/reel.hr)	Reference
Kavieng and Tigak Islands	5.3	Malcomson and Richards, 1982
Kavieng and Tigak Islands	3.9	Wright et al., 1983
Kavieng and Tigak Islands	3.1	Richards and Sundberg, 1984
Southern New Hanover	3.3	Aini, 1993
Kavieng and Tigak Islands	3.1	Wellington and Cusack, 1998
Lihir Island	1.0	Brewer et al 2004

Lokani et al. (1990) estimated the biomass of PNG's deep reef demersal fish stocks to vary between 140 and 418 t/year to 2,300 and 6,900 t/year. Dalzell and Preston (1992) have suggested that in the absence of information on standing stocks of deep-water fish, an empirical figure of 0.7 t/nm of 200-m isobath can be used for estimating stocks. Aini (1993) estimated a standing stock of 14.8 t for an area of 200-m isobath extending for 31.2 nm for southern New Hanover. He predicted that the maximum sustainable yield (MSY) for southern New Hanover lies between 1.5 and 4.9 t/yr, considering the MSY to be about one tenth to one-third of the virgin biomass (see contributions in Polovina and Shomura, 1989). The pinnacle yield for New Ireland has been estimated at 3 t/nm.

Management

A management arrangement for the deepwater red snapper fishery is being prepared for consideration by the NIP PEC and the National Fisheries Board. With very little historical data and even less coming from the new fishermen entering the fishery at this moment, it is not possible to develop a sound management plan.

An estimate of MSY, as qualified by the relevant economic and environment factors should be determined. If little information is available, then the plan should be based on the precautionary approach principle and should consider the current and future developments and market opportunities, both internally and externally.

It should be assumed that catch rates will drop to between one-half and one-third of the virgin catch rates once the fishery reaches a state of equilibrium. This does not necessarily mean overfishing, just a normal response of a stock to fishing pressure. This does, however, have important implications for fishermen who have bank loans to pay off. As a precautionary principle, management arrangements should trigger restrictions when catch rates fall below 50% of initial rates.

Sound management of this resource should be based on reliable and consistent data in order to manage the fishery on a sustainable basis. Therefore, every attempt must be made to ensure that close monitoring of the fishery is carried out and that relevant data are collected for monitoring the status of the fishery. Fishermen should be made responsible for and have some ownership of the fishery and management regulations developed in consultation with them.

BECHE-DE-MER

Resource

Pislama is the general name used in New Ireland Province to refer to either processed or unprocessed sea cucumbers or sea slugs. Various species occur in New Ireland, many of which are harvested for the production of beche-de-mer, the name given to the processed product. Twenty-one sea cucumber species are harvested commercially in New Ireland (App. 3).

Fishery

The beche-de-mer fishery initially concentrated around northern New Ireland, especially the Tigak islands. The high prices paid for beche-de-mer have kept New Ireland sea cucumber stocks under constant pressure for the last 10 years (Butler, 1997). New Ireland exports have been increasing since the resurgence of the beche-de-mer fishery in 1993 with considerable harvests in 1996, 1997 and 1998 (Fig. 4). The export value of the fishery in 1998 was valued at PGK 2.6 million. The fishery has expanded to most parts of New Ireland, moving into new villages and islands (Tutumarem Consultancy Services, 1999).

In 1998, the beche-de-mer purchases in New Ireland accounted for 151.3 t at a value of over K2.56 million. Most beche-de-mer was purchased from the Tigak Islands (59,197.7 kg) and New Hanover (36,789.8 kg). However, the volume had fallen 100 t but the value was the highest ever at K2.72 million.

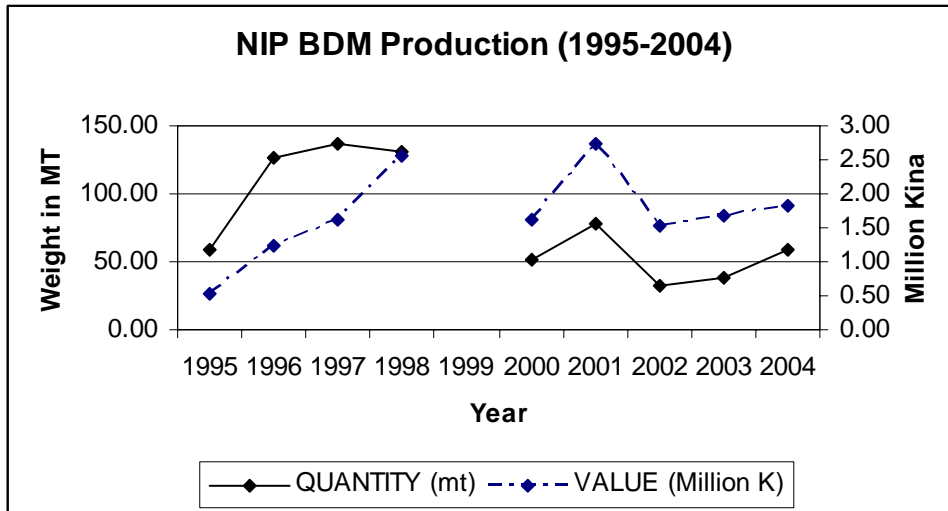


Figure 4: Beche-de-mer exports from New Ireland, 1995–2004. The fishery was closed in 1999. (Source: NFA Export Database)

Up until 1988, the New Ireland beche-de-mer fishery was a single species fishery, consisting solely of *Holothuria scabra*. In 1989, it was still the major species, constituting 92.8% of the total beche-de-mer production. The remaining 7.2% comprised prickly redfish, black teatfish, white teatfish and lollyfish, which started to appear in the catch. In 1990, lollyfish and surf redfish were the major species harvested. Sandfish contributed as little as 12.17% of the catch in that year. In 1991, brown sandfish formed a major component of the beche-de-mer harvest up until 1996; by 1998 it contributed only 15.74% of the beche-de-mer harvest for the year. By 1998, 21 species were being harvested.

Shallow-water species of sea cucumbers, including a large number of species currently being harvested for sale, are collected from seagrass beds, sandy lagoon bottoms, reef crests, slope and surf zones. Deeper water species – including *Holothuria nobilis* (black teatfish), *H. fuscogilava* (white teatfish), *H. fuscopunctata* (elephant’s trunk fish), *Thelenota ananas* (prickly redfish), and *T. anax* (amberfish) – are collected by fishermen using an iron rod with a barb attached to the bottom of a lead weight weighing approximately 3 kg and attached to a rope that is held by the diver. Using a snorkel, the diver manoeuvres the rod directly over the sea cucumber and lets the rod sink and spears the sea cucumber which is then hauled up and drops on to a boat.

No high technology is required for processing sea cucumbers: the animals are boiled, gutted and either sun dried or smoked until they are cured and ready to be sold. Most collectors stockpile their products until there is sufficient quantity to justify a boat trip into town.

Beche-de-mer buyers purchase directly from the fishers. The products are further processed to maintain quality, and are stored in polypropylene bags for export.

Current status

Over a thousand people are involved in the processing and selling of beche-de-mer in New Ireland Province. Data from August 2003, obtained from Emirau Marine Products (EMP), showed that 1,066 people (835 of whom were males) sold beche-de-mer to EMP. Over 110 villages were involved and 20 sea cucumber species were harvested.

There are contradictory opinions regarding the status of sea cucumber stocks and production in the province. The general conclusion is that sea cucumber stocks are overfished in the northern area while in southern areas, stocks may be lightly fished. Hair and Aini (1996), however, observed low densities of sea cucumbers at the far southern end of the main island of New Ireland. Despite these assumptions, it is believed that most of New Ireland's deeper sea cucumber stocks are probably underfished.

One exporter suggested that stocks are healthy, and because of better prices offered by the agriculture sector, harvesting has decreased. He admitted, however, that there had been overfishing of the shallower water species, especially sandfish, in the Tigak Islands, parts of Djaul and New Hanover.

It is apparent that most of the shallow-water species are overfished in many parts of the Kavieng area, including the offshore islands. Only 3.2% (864 kg) of the once major export species sand fish was exported in 1998.

According to Satarek Taput, NIP Provincial Fisheries Advisor, the total allowable catch (TAC) for sea cucumbers over the past few years has not been reached until the compulsory seasonal closure from 1 October to 15 December. Taput also suggested that beche-de-mer production in the province is decreasing.

Although it is illegal, undersized beche-de-mer species are being purchased. Random samples of 20 kg (from 40-kg bags) of sandfish were processed and 69% of these were under legal export length (Aini, 2000).

The TAC for New Ireland is based on pre-1996 data and surveys. To date, no stock assessment survey for the province has been conducted. Such a survey is required in order to review the current TAC and standing stocks for the province, and to re-determine the minimum legal size restrictions placed on certain sea cucumber species in light of significant harvests in recent years.

Comparisons done elsewhere of legal minimum sizes of sea cucumbers indicate that some of species harvested are less than the length at first maturity for that species (Table 4).

Table 4: Comparison of legal minimum sizes (live and dry) against length at first maturity (live and dry) (Source: Preston (1993), in Butler (1997); Conand (1989), in Butler (1997))

Common Names	Legal minimum size		Length at first maturity	
	live length (cm)	dry length (cm)	length at first maturity – alive (cm)	length at first maturity – dried (cm)
Sandfish	22	10	16	11
Black teatfish	22	10	26	13
White teatfish	35	15	32	16
Prickly redfish	25	15	30	15
Deepwater redfish	25	15	12	6
Elephant	45	15	35	18
Surf redfish	20	8	22	11
Curry fish	25	10	27	14
Lolly fish	30	15	16.5	8

Sea cucumbers in bold highlight were harvested before length at first maturity.

Management

The beche-de-mer fishery in New Ireland is managed under the Papua New Guinea revised National Beche-de-mer Fishery Management Plan 2003, a plan that manages the beche-de-mer fishery for the entire country.

Sea cucumber (beche-de-mer) management regulations

Collecting sea cucumbers – and the production of beche-de-mer, trading and export of them – are guided by rules set under the National Beche-de-mer Fishery Management Plan, as shown in table 5.

Table 5: Beche-de-mer size limits in Papua New Guinea (Source: National Beche-de-mer Fishery Management Plan)

Common Name	Scientific name	minimum size	
		live	dried
<i>High value sea cucumbers</i>			
Black teatfish	<i>Holothuria nobilis</i>	22 cm	10 cm
Blackfish	<i>Actinopyga miliaris</i>	15 cm	10 cm
Curryfish	<i>Stichopus hermanni</i>	25 cm	10 cm
Greenfish	<i>Stichopus chloronotus</i>	20 cm	10 cm
Prickly redfish	<i>Thelenota ananas</i>	25 cm	15 cm
Sandfish	<i>Holothuria scabra</i>	22 cm	10 cm
Stonefish	<i>Actinopyga lecanora</i>	15 cm	10 cm
Surf redfish	<i>Actinopyga mauritiana</i>	20 cm	8 cm
White teatfish	<i>Holothuria fuscogilva</i>	35 cm	15 cm
<i>Low value sea cucumbers</i>			
Amberfish	<i>Thelenota anax</i>	20 cm	10 cm
Brown sandfish	<i>Bohadschia vitiensis</i>	20 cm	10 cm
Chalkfish	<i>Bohadschia similis</i>	25 cm	7 cm
Deep-water redfish	<i>Actinopyga echinites</i>	25 cm	15 cm
Dragonfish	<i>Stichopus horrens</i>	none	None
Elephant trunkfish	<i>Holothuria fuscopunctata</i>	45 cm	15 cm
Flowerfish	<i>Pearsonothuria graeffei</i>	none	None
Lollyfish	<i>Holothuria atra</i>	30 cm	15 cm
Pinkfish	<i>Holothuria edulis</i>	25 cm	10 cm
Snakefish	<i>Holothuria coluber</i>	none	None
Tigerfish	<i>Bohadschia argus</i>	20 cm	10 cm

Other important rules

- Closed season for harvesting sea cucumbers is 1 October–15 January. The closed season may begin earlier if the total allowable catch⁶ is reached before 1 October.
- The harvesting of all sedentary⁷ animals, including sea cucumbers, at night using underwater lights and/or using scuba and hookah gear is prohibited.
- All exporters of beche-de-mer must have a license issued by the National Fisheries Authority. Licenses are restricted to nationally owned companies and there are limits on the number of licenses in each province. NFA can terminate licenses if the license holder breaks the Management Plan rules.

⁶ Total allowable catch (TAC). The total amount of sea cucumbers NFA allows to be harvested in a 12-month period before it closes the season. That amount is measured in tonnes. Each province has a different total allowable catch.

⁷ Sedentary animals are those that do not move or move very slowly. Examples of sedentary marine animals are pearl oysters, sea cucumbers, corals, and trochus.

TROCHUS

Resource

Trochus (*Trochus niloticus*), locally known as lalai, is a relatively slow growing gastropod that lives in depths of up to 10 m on certain areas of reef slopes. Trochus are harvested for their shell, and the meat is consumed locally. All harvested trochus shells are exported out of the province to Rabaul or overseas.

Two other trochus species (*T. maculatus* and *T. pyramis*) exist but are currently of no commercial value.

Fishery

Because trochus inhabit an easily accessible area on coral reefs, they are readily found and collected by free diving. No sophisticated processing methods are required to prepare the shells for sale. The shells are either boiled to extract the meat or, when a large collection has been made, are simply buried in sand for several days until the meat decays. The shells are then rinsed in seawater to wash out any remains of the decaying animal and are stock-piled until there is sufficient quantity to sell to exporters in Kavieng.

On the northwest side of New Hanover, some locals bury their processed shells in the sand in order to maintain a fresh look. In other areas, shells are simply stored in cool areas away from the sun.

Shells are further cleaned using cement mixers to churn the shells in fresh water and dried before they are packed by grade in polypropylene bags by the exporter.

These bags are stored in transport containers until enough quantity has been accumulated for export. According to one of the three exporters, Mr Eugene Schulze, of Durima Ltd, the minimum quantity of trochus that can be exported is 3 t, and in some cases, overseas buyers cannot take less than 10 t. Most New Ireland shells are exported to Japan and Hong Kong for the production of buttons.

In 1995, Hair and Aini (1996) estimated that 46 villages in the province were involved in harvesting trochus. At that time, trochus prices ranged from PGK 2.50–4.00/kg. From purchase dockets, it was estimated that 26.9 t, valued at over PGK 86,000, were purchased from the province. The greatest purchase came from Mussau/Emirau (1,226 kg). The NFA export database includes trochus and other shellfish in the shell categories.

Reef surveys conducted between 1988 and 1990 estimated that trochus densities ranged from 34 trochus/ha in Djaul to 135 trochus/ha in Mussau (Tenakanai, 1990). This is said to be well below published criteria for harvestable trochus resources (McGowan, 1958 in Tenakanai, However Tenakanai (1990) pointed out that the figures were biased because the surveys were done during daylight hours.

Current status

Mr Schulze stated that trochus purchase prices have been steady for the last four years at PGK 4.00/kg. Three trochus buyers currently operate in New Ireland and export on a regular basis. According to one buyer, most of the shells he purchases come from the northern end of New Ireland.

The shells are graded according to the basal diameter (i.e. all 12 cm shell are graded as 'large', 10 cm, as 'medium', and 8 cm as 'small'). Another buyer grades his shells as follows: "A" grade shells are between 8 and 10 cm basal diameter; 'B' grade are

between 10.5 cm and 12 cm basal diameter. Shells that are undersized, oversized, damaged and/or have bore holes are discarded, and sometimes used to mix cement (Warina Mangels one of the principals of EMP⁸, pers. comm.)

The quantity of large shells (i.e. those with a basal diameter of 12 cm and greater) sold to one exporter are decreasing and the proportions of smaller and medium sized shells are increasingly being sold (Reinhart Mangels, EMP, pers. comm.).

Without proper data, it is difficult to assess whether trochus harvests are decreasing, increasing or remaining steady. Schulze (pers. comm.) indicated that trochus stocks are healthy and because most stakeholders are also involved in agriculture activities, trochus sales are slow. About half of the New Ireland shells are exported through Manus by one of the exporters based in New Ireland.

Management

Export data cannot directly be used to assess stocks in the province because these data do not represent the actual harvest quantity for the province.

Overseas buyers prefer smaller size shells (6–8 cm basal diameter; Schulze, pers. comm.) and the tendency to export such sizes is high without consistent enforcement of current regulations.

Because no stock survey is likely to eventuate in the near future, existing regulations must be enforced (i.e. maximum and minimum size restrictions). Community awareness, education, and involvement in community management are encouraged.

A number of locally managed marine areas (LMMAs) are scattered around the province. If these LMMAs are recognized through existing legislation that empowers communities to prosecute and to take matters into court, these areas ensure sustainable harvests of future stocks.

Trochus management regulations

The harvesting, trading and export of trochus shells are regulated through a notice of prohibition issued by the Chairman of the National Fisheries Board and published in the National Gazette number G57 (4 April 2002).

Size limits

- All species of trochus with a minimum basal width of 8 cm and a maximum basal width of 12 cm shall not be harvested and exported.

Other important rules

- The harvesting of all sedentary animals, including trochus, at night using underwater lights and/or using scuba and hookah gear is prohibited.
- All commercial buyers must have a license issued by the National Fisheries Authority. Licenses are restricted to nationally owned companies, and there are limits on the number of licenses given in each province. NFA can terminate licenses if the license holders break these management rules.

⁸ Emirau Marine Product Ltd is one of the exporters of trochus in Kavieng.

BAITFISH

Resource

The baitfish resource in New Ireland are mostly of the type used for supplying the pole-and-line and tuna longline fisheries. The pole-and-line fishery targets two species of anchovies (*Stolephorus heterolobus* and *S. devisi*) and one species of herring (*Spratelloides gracilis*) (Dalzell and Wankowski, 1980).

There also a good quantity of tuna longlining bait including barred garfish (*Hemiramphus far*), scad (*Selar crumenophthalmus*), carangid (*Selaroides leptolepis*) (Sokomi and Chapman, 2001), herring (*Herklotsichthys quadrimaculatus*) and *Sardinella* spp. (Sokomi and Simon Pooley, pers. comm.).

The major baiting grounds used by the tuna pole-and-line fleet in the 1980s in New Ireland included Ysabel Passage, north of New Hanover, the Silver Sounds in the Tigak Islands, and Three Island Harbour on the northwest coast of New Hanover.

Fishery

The resource is currently not being exploited on a commercial level. Given the future longlining prospects in the province, there may be an opportunity to harvest larger baitfish species that periodically school in lagoons and bays around the province.

Bait fishing for the pole-and-line tuna fishery has focused on catching the smaller anchovies and sprats that can be kept alive for the duration of a fishing trip. A detailed description of catch methods is given by Dalzell and Wankowski (1980).

Baitfish are caught using a rectangular fine mesh net call a bouke-ami net. This is a rectangular fine meshed net. A light is hung from a bamboo rod over the side and lowered into the water. The baitfish are attracted by the light and aggregated around the light. When it is estimated that there is enough baitfish around the light, the light is slowly dimmed and the baitfish compact into as very tight school. The bouke-ami is lowered into the water over the side of the boat and slowly pushed out under the baitfish and then slowly raised to the surface and forms a purse entrapping the baitfish. The purse is then slowly pulled in alongside the boat and the baitfish are then scooped into bait wells on the tuna catcher boats.

During the 1970s and early 1980s, up to 1,200 t of baitfish, together with incidental catches of other small fish species, provided the basis for the tuna pole-and-line industry that operated out of Kavieng (Tutumarem Consultancy Services, 1999).

Current status

Commercial harvesting of baitfish — either for sale or to use for bait — does not take place, except for the occasional netting of malabur (*Selar crumenophthalmus*) and talai (*Herklotsichthys quadrimaculatus*). These two species are also harvested for subsistent consumption. Malambur is always sort after and is occasionally sold at the freshfood market. In light of recent infrastructural developments, the harvesting of baitfish for tuna longlining operations may commence in the near future.

Management

No management guidelines for bait fish are in place. However fishery dynamics of relevant bait fish species for longlining should be considered in the case when a tuna longline operations has commenced in NIP.

CORAL REEF FOOD FINFISH

Resource

The major coral reef food finfish include lutjanids (snappers), lethrinids (emperors), carangids (trevallies), labrids (wrasses), serranids (cods, groupers and coral trouts), sphyraenids (barracudas), mugilids (mulletts), scarids (parrots), acanthurids (surgeons, tangs, and unicorns) and siganids (rabbit fish).

Over 250 coral reef food finfish, representing 43 fish families have been recorded in New Ireland in 1980 (Wright and Richards 1985).

Fishery

The fishery involves catching reef associated food fish for local consumption and sales at the main produce market, fish buyers in Kavieng, or for sending to relatives in other parts of the country. Caught by a variety of fishing methods, these fish are either smoked, chilled in ice, or if caught the night before, are transported fresh to town for sales. Most of the smoked and recently caught fish are sold at the market, while the chilled fish are sold to fish buyers, restaurants and fish shops.

Fishers prefer to sell their fish at the main market where they get the best prices. What is not sold at the market, especially for the recently caught fish and chilled is normally taken to fish buyers in town to be sold.

The main fishing methods used to catch coral reef food fish are handlining, netting, spear fishing, and trolling. Fish buyers prefer chilled fish that were caught by hand lines, nets or by trolling. Fish that have been speared are also bought if they were speared in the head (i.e. no spear holes through the body).

In the Tigak Islands, the annual subsistence harvest from 20,765 ha of reef and associated environments (in depths less than 30 meters) was estimated to be 0.63 kg/ha/yr. The annual artisanal catch for this same area was estimated to be 3.54 kg/ha/yr (Wright and Richards, 1985).

Wright and Richards (1985) estimated the catch rate for different fishing methods: handlining, 1.2 kg/line hr; day spearfishing, 1.2 kg/line hr, night spearfishing, 3.6 kg/line hr, seine netting, 3.9 kg/line hr and trolling, 4.0 kg/line hr.

Current status

This is one of the main fisheries in the province apart from the beche-de-mer fishery. Compared with the past when only the surplus, or “left over” subsistence catch, was sold at the markets, today many people are fishing to earn cash.

There has been a shift in species composition for the fishery, from mugilids, to shallow-water snappers and emperor fish. This change also reflects a change in, or the domination of, a particular fishing method, from netting to line fishing. Spear fishing is also an important fishing method during certain months of the year especially when diving, fishers are targeting spawning aggregations.

There is only one major fish buyer who buys fresh fish in Kavieng at present. Others buy fish intermittently when there is enough storage space (usually in deep freezers) and enough cash to purchase fish.

Fish sold at the main produce market is usually smoked, and it is typically the women who are involved in sales. On Saturdays, there is both smoked and fresh fish available at the market.

Management

Coral reef food finfish resources are not directly protected under any fisheries regulations. Indirectly, they are protected under the Fisheries Management Act, which prohibits the use of noxious substance and explosives to capture fish.

The local practice of traditional reef area closures by local communities is the only local management in place. In some parts of the province, however, these areas are small and closure periods may only last for three months or less. In other areas where traditional practices are still in effect, areas closures are large and certain reef areas are permanently closed.

The reasons for the traditional practices of reef area closures are many. Preservation of fish stocks may only be a by product of closure that is in place because of other reasons including a permanent closure of the land and forest area or mouth of a river, which would extend to the adjacent reef and sea area. This practice would be associated with the origin of an ancient dance or home of an animal (e.g. a very old python snake), which would have been the origin of the clan. These areas would be tabooed and closed to all activities including any fishing activity. Reasons for temporary closures would include death of a clan leader or dispute over land adjacent to the reef. These usually last a few months until certain feasts or compensation payments or some settlements have been made.

In the Tigak Island communities, resource management discussions are underway, and include the possible prohibition of outsiders from fishing in their areas. In other areas of New Ireland, attempts at resource management are being made through the establishment and strengthening of locally managed marine areas (LMMAs). The introduction the community-based fisheries management being implemented by the NFA/ADB Coastal Fisheries Management and Development Project (CFMDP) would also assist in strengthening the traditional customary practices in the management of some of the reefs and sea areas.

The capturing of spawning coral reef fish is becoming more common, especially for paddle tails (*Lutjanus gibbus*), some emperors and sweetlips, and rabbitfish. There is need for education and community awareness on the importance of spawning aggregations and the implications of continuously removing a large number of fish while they are spawning, as part of the general awareness on caring of the marine resources.

LIVE REEF FOOD FISH TRADE

Resource

Fish from the Serranidae (cods, groupers and coral trouts) and Labridae (wrasses) families are the primary targets of the trade but a number of other species are also sought after, including snappers, emperors, trevally and reef stonefish (Aini and Hair, 1995).

These fish are also targeted by local fisherman for subsistence and commercial purposes. Twenty-nine fish species from six families have been recorded as being utilised as food fish by communities in New Ireland Province (Aini and Hair, 1995). Additional species not targeted by the trade but exported were observed and recorded, and details of these are found in Appendix 4.

Fishery

The LRFFT involves catching certain reef fish species (App. 4) and keeping them alive in pens until there are enough fish to be freighted overseas, primarily to Asian countries. These live fish are either airfreighted or transported by specially-built boats to overseas markets. From Kavieng, all exports are transported by boat.

The LRFFT first began in New Ireland in 1992 (a company was licensed to operate around the east coast of New Ireland). Due to unsuitable fishing grounds, however, the company terminated operations and moved to Kavieng in June 1994. The same company had operated in East New Britain (ENB) prior to coming to New Ireland. The company exported live fish and live lobsters that were harvested from Tanga Island in New Ireland. Kavieng's first export, which was airfreighted to Hong Kong, was 250 kg of live lobsters valued at USD 3,125 (Aini and Hair, 1995).

During 1995, a joint venture company involving Tigak Marine Supplies (Tigak Island), National Marine Harvests (NMH) from Port Moresby, and Charter Wide Investments (CWI) of Hong Kong, sought approval from the New Ireland provincial government and the then Department of Fisheries and Marine Resources, to operate a LRFFT company in New Ireland. The joint venture company intended to concentrate its fishing operations in the Tigak Group of Islands between New Ireland mainland and New Hanover and along the east coast of mainland New Ireland with the intent of expanding to Djaul, New Hanover, Emirau/Mussau, Tabar, Lihir and Tanga Islands. For unknown reasons, the operations of this joint venture company did not materialise. CWI with NMH and D'entrecasteaux Youth Marine Supplies, however, formed a joint venture company and moved operations to the D'entrecasteaux Islands in Milne Bay Province.

The LRFFT had been based at various parts of New Ireland including: Kavieng Harbour; Bangatan Island and Pati in the Tigak Islands; Mait Island in Djaul Island; Sosson and Tingwon Island near West New Hanover; Lyra Reef; and two areas in the Tsoi Group. In some of these areas the company deployed fish cages for communities to hold live fish to be purchased by the company.

A variety of fishing methods were used, including hook-and-line, net fishing (trammel nets), trap fishing (normally covered by corals broken from reefs — habitat traps), bottom longlining, hookah and bait line, hookah and scoop net, *Derris* roots in squeeze bottles, and spear fishing, which is normally used to catch food fish (Aini and Potuku, 1997). Islanders and an ex-fisheries surveillance officer (residing on Djaul Island), reported that LRFFT operations were using sodium cyanide to catch fish.

Mobiha (undated) estimated the reef area around Djaul, which was fished by LRFFT operators, to be 1,160 ha. Fish species targeted by the trade numbered; Labridae (22) and Serranidae (47). Density estimates for these two fish families are 0.32 fish/m² for Serranidae and 0.14 fish/m² for Labridae (Mobiha, undated). These estimates do not necessarily account for the actual number of species targeted by the LRFFT as fish identification may have been a problem.

Current status

In 2000, the National Fisheries Board at one of its regular meeting (No. 4/2000, Decision No. 59/2000) decided that a live reef food fish project be conducted in New Ireland and Manus. Results of this trial operation would be used to assess the viability of the fishery and to formulate a management plan for the sustainable harvest of reef fish in PNG.

From February to October 2000 in NIP, a trial project was based out of the Tigak Islands, Soson and Tingwon Islands. During the six-month period, 6.1 t of live fish were exported to Hong Kong, fetching over PGK130,000.00. Of this, around PGK11,000.00 was paid out to fishers in the three management areas while between PGK4,000.00 and PGK5,000.00 was paid to accounts of affected communities. Fishing was restricted to trapping and handlining. The trial project in part concluded that generally there is a desire for the resource owners within the trial areas to participate in the live reef food fish fishery, which they believe had provided the much needed opportunity to generate income.

The LRFFT operation ceased working in New Ireland Province and moved its field station to Milne Bay Province in February 2004. However a small but much localised operation is based at Bangatan Island in the Tigak Group, using two old boats that were initially anchored in Kavieng Harbour near Bagail village (and which were used as office space, accommodation, fish processing, beche-de-mer drying facilities, outboard motor mechanic shop and general workshop).

Spawning aggregations

The Nature Conservancy (TNC) in collaboration with NFA conducted a survey of spawning aggregation in parts of New Hanover and Tigak during 2000. A summary of spawning sites from Lokani (undated) is presented in table 6 below.

Table 6: Spawning sites in the Kavieng area. Summarized from Lokani (undated)

Areas	Potential Sites	Actual spawning Sites
Tigak Islands	9	2
Tingwon Islands	5	1
Sosson Islands	9	2

In 2003, TNC funded a spawning aggregation workshop involving representatives of various NGOs and government agencies. The workshop was held at the National Fisheries College (NFC) and the field training at Mait Island, Djaul. Participants were trained to identify, quantify and map spawning aggregation sites.

Management

The LRFFT is managed under The National Live Reef Food Fishery Management Plan. Management measures include catch limits, restrictions on fishing methods and areas of operations, reporting procedures, and other requirements detailed in the plan.

Live reef fish management regulations

Size limits

- Humphead Maori wrasse (*Cheilinus undulates*): 65 cm
- Mangrove jack (*Lutjanus argentimaculatus*): 40 cm
- Maori perch (*Lutjanus rivulatus*): 55 cm
- Moses perch (*Lutjanus russellii*): 24 cm
- Red emperor (*Lutjanus sebae*): 55 cm
- Barramundi cod (*Cromilepes attivelis*): 40 cm
- Flowery cod (*Epinephelus fuscoguttatus*): 55 cm
- Camouflage grouper (*Epinephelus polyphekadion*): 37 cm
- Squaretail coral trout (*Plectropomus areolatus*): 36 cm
- Chinese footballer trout (*Plectropomus laevis*): 60 cm
- Leopard coral trout (*Plectropomus leopardus*): 36 cm
- Highfin coral trout (*Plectropomus oligacanthus*): 36 cm

Restrictions on fishing methods

- Fishing for live reef food fish is restricted to handlining only.
- The licensee shall be allowed one permanent fish cage for holding fish in each management area. Cages shall have a dimension of 10" x 10" x 12" with a holding capacity not exceeding 500 kg.
- For transshipment purposes, fish cages may be towed to one management area *only* upon receipt of written approval form NFA at least fourteen days prior to actual transshipment.
- A quarantine cage shall be constructed separately from fish cages for storing diseased fish for observer and quarantine purposes.

Other important rules

- Export by the licensee of target species of sizes less than the approved size limit is prohibited.
- Fishing within or close proximity of a declared spawning aggregation site is prohibited
- Fishing for live reef food fish or other related activities within or close to the known diving spots is prohibited
- Fishing for live reef food fish within the Torres Strait Protected Zone is prohibited.
- Fishing for live reef fish shall be restricted to only resource owners employing fishing methods.
- The use, storage and transportation of explosives, noxious substances (including cyanide and naturally derived substances in any form) for the purpose of killing, stunning, rendering disabled or capturing of fish is prohibited.
- The use of hookah gear and scuba for capturing fish for live reef food fish is prohibited.
- NFA reserves the right to cease live reef fish operations in a management area if it considers it necessary in order to maintain a healthy reef fish stock

LOBSTERS

Resource

The tropical lobster fishery in New Ireland is based on five species: *Panulirus penicillatus* (double-spined rock lobster), *P. versicolor* (painted rock lobster), *P. longipes femoristigma* (blue-spot rock lobster), *P. homarus* (scalloped rock lobster), and *P. polyphagus* (dentate rock lobster). The fishery also includes the slipper lobster or "bug", *Thenus orientalis*, as bycatch. The migratory ornate spiny rock lobster (*P. ornatus*), which constitutes the single largest lobster fishery in the Torres Strait and parts of the Central and Gulf Provinces, has also been recorded in New Ireland. These lobsters live in shallow reefs and prefer rocky bottom and crevices. Their larvae drift about ocean currents for periods of between 6 and 12 months.

Kindam is the general name used by New Irelanders to refer to all lobster species, including the slipper lobsters.

Fishery

Lobsters are normally caught by free diving and as by-catch of other fishing activities. Lobsters are generally targeted for subsistence purposes, although recently, due to the presence of markets and a consistent buyer in Kavieng, lobsters are now being targeted for sales.

Lobster fishing activities by subsistence and artisanal fishermen are conducted at night, during periods around a new moon. The most common fishing method is to walk along the reef flats at night and catch the lobsters by hand. In free diving (using waterproof underwater torches), lobsters are collected along the surf zone by hand and placed in mesh bags, baskets, or in used rice bags, and later taken into town for sales. In the past, some fishermen used tangle nets, although these are not commonly used today.

Lovongai Islanders use freshly killed octopus as bait to lure lobsters out of their crevices. Fishers prefer to catch *P. penicillatus* and *P. longipes* by hand when they come to the reef top at certain tides and times of the moon; *P. versicolor* is mainly caught by spear fishing.

Wright et al. (1983) recorded four species of lobster and indicated that *P. versicolor* appeared to be the most common lobster on New Ireland reefs. They estimated that 8.4 t of lobster are harvested each year from reefs adjacent to Kavieng, primarily from the reefs of Tsoi islands, north of New Hanover.

Lobsters are sold live to consumers or to various buyers in Kavieng, including the Kavieng Hotel, Malagan Beach Resort, and Nusa Island Retreat.

During 1995, an estimated 19,148 kg of lobsters, worth PGK 62,523, was recorded from New Ireland Province (Hair and Aini, 1996). Over 40% (7,860 kg) of this was harvested from the Kara Nalik area on the east coast of mainland New Ireland, where 25 villages were involved in harvesting. The Tsoi Group, with only 8 villages, harvested the second highest number of lobsters (3,179.30 kg).

Only a small number of buyers and exporters are involved in exporting lobsters from New Ireland Province. Between 1999 and 2004, between 4 and 14 t of live and frozen lobster tails with a total value of PGK 2.7 million were exported (Fig. 6). The highest export was made in 2002 with 14 t of frozen tail and lobsters worth PGK1.1 million.

Current status

The lobster season in New Ireland begins around March, which coincides with the onset of relatively calm periods. Most of the lobsters sold in Kavieng are from the Namatanai and Mussau areas (Warina Mangels, *pers. comm*). The current buying price for live whole lobsters is PGK 6.00 per kg.

Contrary to Wright et al.'s findings (1983) that *P. versicolor* dominated lobster catches in New Ireland Province, Hair and Aini (1996) found *P. penicillatus* to be the most common species, constituting 98% of the total lobster catches in New Ireland in 1995. Recent observations and discussions with fish buyers, confirm a resurgence in *P. versicolor*, especially from Djaul.

Once a week during lobster season, a pick-up truck makes a run down the coast to buy and collect lobsters from the villages along the Buluminski Highway. This service makes it easier for the people to sell and deliver their catches, and as a result, more people are now diving for lobsters.

Most of the lobsters that are purchased already have their tails removed. Export is mainly to Australia, although some are retained for sales domestically, to both retail and to restaurants.

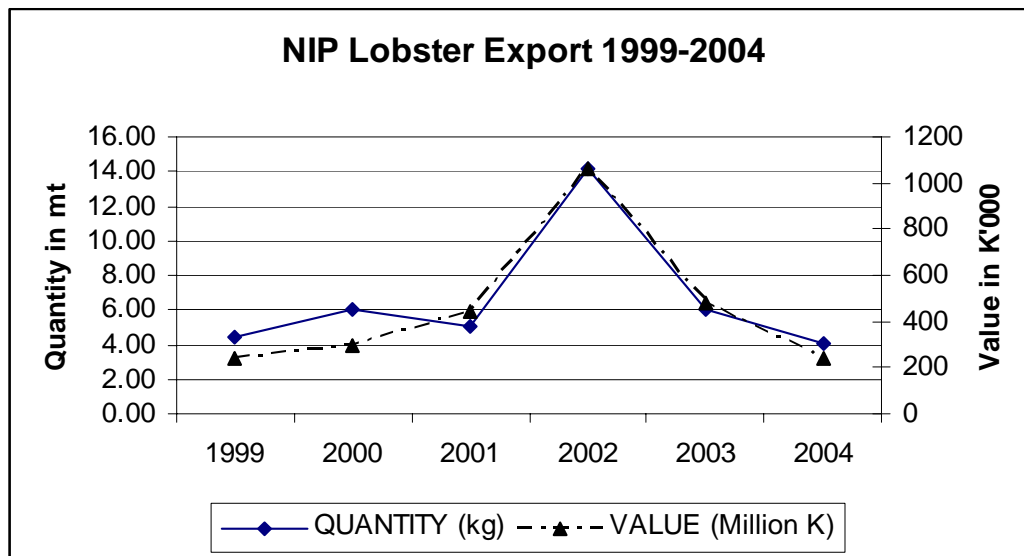


Figure 4: Lobsters (frozen and live) exported from Kavieng between 1999 and 2004. (Source: NFA database–October 2005)

Management

The size at which lobsters reach maturity is an important consideration for management. The principal lobster fishery in PNG is in the Torres Strait, and the Western Province has a management plan for a single species, the migratory ornate spiny rock lobster *Panulirus ornatus*. No other province has a management plan for lobster exist however, the taking, buying and exporting of lobster is guided by the National Lobster Fishery Management Plan. The national plan is broad and covers the multi species fishery.

Lobster management regulations

Fishing, trading and export of lobster are guided by rules set under the National Lobster Fishery Management Plan.

Size limits

- All species of rock lobster (painted lobster–*Panulirus versicolor*, long legged lobster–*P. longipes*, and scalloped lobster–*P. homarus*) with a *minimum tail length* of 10.0 cm to total length (midsection between the eyes to tail) of 17.5 cm shall not be harvested and exported.
- All species of rock lobster with a *minimum tail weight* of 169 gram and an overall weight of 409 gram shall not be harvested and exported.
- The minimum tail length of the ornate rock lobster (*P. ornatus*) is 11.5 cm; *P. ornatus* shall not be harvested or exported.
- The minimum carapace length (midsection between the eyes to the base of the carapace cover) of slipper lobsters is 5.2 cm; slipper lobsters shall not be harvested or exported.

Restriction on egg-carrying females

- Berried (egg-bearing) female lobsters shall not be taken at any time of the month or year.

Other important rules

- All commercial buyers must have a license issued by the National Fisheries Authority.
- Licenses are restricted to nationally owned companies and there are limits on the number of licenses in each province. The National Fisheries Authority can terminate licenses if the license holder breaks the Management Plan rules.
- Some gear restrictions apply to the harvesting of lobsters. Check with the National Fisheries Authority or with your local provincial fisheries department.

MUD CRABS

Resource

The mud or mangrove crab (*Scylla serrata*) is locally known as aluang, and is the only known species of mud crab sold commercially in New Ireland. Distinct differences in the crabs sold at the Kavieng market have been identified, suggesting that more than one species of mud crab may exist in the province. Most crabs found in New Ireland inhabit muddy or silty type mangrove habitats. Some mud crabs also inhabit river mouths and even areas upriver where sea water mixes with fresh water.

Fishery

Mud crabs have been traditionally harvested by women for supplementary protein. Crabs are usually boiled in coconut milk for local consumption and are also sold live at the Kavieng main public market and to local restaurants.

According to one mud crab collector, the best time to catch crabs is when the tide is low and during a new moon. This is thought to be when the crabs are mating.

Mud crabs are caught using a variety of methods, depending on the tide and location. During low tide in the mangrove forest, collection is by hand, using a stick with a barb, ensuring that both claws are immobilized at the same time. If the crabs are suspected to be inside a mud hole (which many locals believe to be a crab's home, or mating and moulting place) they are pulled out using a stick with a barb at the end. When this stick is inserted into the hole, it is placed at the back end of the crab and is used to force the crab out. Collectors sometimes collect two crabs (a male and female) at the same time from the same hole.

During high tide at the edge of the mangrove forest and areas of sea in the direct vicinity of a mangrove forest, a four-pronged stick is used to hold the crab against the sea bed while the collector picks it up by hand. Crabs are also sought after at night with pressure lamps and speared for local consumption.

The crabs are wrapped in leaves with some mud to keep them moist and tied with bark strings. Crabs can survive and in good condition for a few days when kept tied and in a cool place. Collectors then "stockpile" the crabs until they have enough to sell, either at the public market, or to buyers, restaurants and hotels. Those crabs that are sold to buyers are generally exported, either whole or as crab meat. Crab meat is extracted from the claws after boiling and packed into plastic bags for export.

In 1995, 7,283 kg of mud crab, worth over PGK 20,000, was sold in Kavieng. Hair and Aini (1996) found that approximately 63% of all mud crabs sold were purchased from Kavulikiau village in the Tsoi islands around north New Hanover, and from Tugalop Island in the Tigak Islands. This coincides with large areas of mangrove

forests in these areas. A further 20% originated from the Tigak mainland, mostly from Tome village on the Balgail Bay. These figures are underestimates of mud crab production in the area, as an unknown yet significant quantity is believed to come from Siwasat, Kaplaman and other villages around Kavieng town, and sold directly to town residents and tourists. Most of these villages would get their crabs from Balgai Bay south of Kavieng town

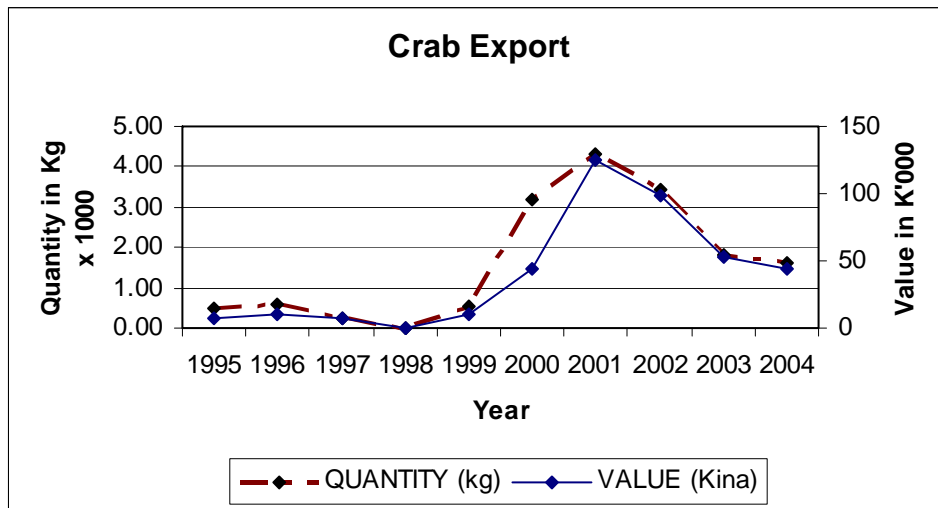


Figure 5: Crab export from NIP during the last 10 years (Source: NFA Export Database)

New Ireland Province exports much of its crabs overseas. Since 1995, New Ireland Province has been exporting an average of 1.63 t of crabs worth PGK39,740 annually. Exports did not pick up until 2000 and dropped again in 2003. The highest export was made in 2001 with 4.0 t of crabs worth PGK124,000.

Current status

There is a small-scale artisanal mud crab fishery in New Ireland. Today, the harvesting of mud crabs is market driven, mainly because of high demand by restaurants and visiting tourists. Mud crabs are also in demand locally, and as a result, prices for crabs have increased. An average size crab of 14–15 cm at the main market or from a roadside stand may cost PGK 6.00 or more. Exporters buy crabs at PGK 3.00/kg.

According to interviews with crab collectors from Bagail village in Kavieng, mud crab stocks around the Kavieng area are declining and fewer numbers of crabs are collected per day than in the past. Crab collectors must travel farther from the village to collect crabs. This decline is attributed to the destruction of mangrove forests (by excessive cutting of trees for house building) and the destructive collecting practices where crab holes are damaged while trying to remove the crab.

Management

There is no national or provincial management plan to protect crab resources. Buyers in New Ireland are discouraged from purchasing small crabs and those that are moulting. The quantity sold is not representative of the whole province and any assumption of declining stocks may only apply locally to the Kavieng area, especially Balgai Bay.

Tutumarem Consultancy Services (1999) suggested implementing regulations for protecting mud crab resources in New Ireland, should exploitation levels increase. These regulations may include:

- prohibiting the harvest of all females,
- prohibiting the harvest of all males less than 150 cm carapace width,
- introducing a closed season, governed by the reproductive period of local populations,
- protecting mangrove habitats, and
- working with local communities to establish reserves in mangrove habitat, within which harvesting would be totally prohibited.

MARINE TURTLES

Resource

Marine turtles come under the jurisdiction of the Ministry of the Environment and Conservation, but is briefly reported on here.

There are six species of marine turtles in the South Pacific, and most of these are found in Papua New Guinea, including the green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), flatback (*Natator depressa*), leatherback (*Dermochelys coriacea*) and olive ridley (*Lepidochelys olivacea*).

Island residents are confident that there are more species that have not yet been described and which occur in the waters around New Ireland. For instance, people around Ysabel Pass have reported seeing red-coloured turtles on patch reefs between the Tsoi islands and mainland north New Hanover.

Turtles commonly seen in Kavieng waters include the hawksbill, green and leatherback. Green turtles are the preferred species for eating.

Fishery

New Ireland fishermen normally do not target turtles as a source of protein, and they do not specifically search out turtle eggs. Turtles are only caught when encountered during fishing trips or when travelling at sea. Immigrants from Manus, however, especially hunt for turtles for direct consumption and not for sale. Very few turtle products appear in the market.

In analysing Department of Primary Industry (DPI) records, Wright et al. (1983) found that 1.8 t of turtle, 95% of which were green turtles, are harvested annually from the Tigak Islands. No current records of harvest are available.

Marine turtles are rarely harvested commercially. Occasionally at the Kavieng market, smoked turtle meat and turtle eggs are sold, as are small, stuffed hawksbill turtles. On a few occasions small-sized live turtles are also sold.

Turtle sightings are frequent throughout the Tigak Islands and towards southern New Hanover. Several sightings (mainly of green turtles) have been made in the waters between Djaul and Baudissen Pass, and around Mait Island in Djaul.

During the 1995 Lak Marine Survey at the southernmost tip of New Ireland, 10 turtle sightings were recorded, 6 of which were hawksbill turtles (Hair, 1996). Information from Lombom Islanders suggests there are frequent sightings of unidentified turtles species during fishing trips or when travelling. Hair (1996) reports that one of the sightings was a pair of mating hawksbill turtles.

Current status

Many New Irelanders catch turtles incidentally while conducting other fishing activities. Limanak Islanders sometimes specifically target turtles when they want to eat turtle meat (Bitura, fisherman, pers. comm). Manus people living in New Ireland target turtles, especially green turtle for feasts, funerals and occasionally for consumption or when are asked by relatives or friends to do so. In the Kavieng area, these turtles are mostly hunted around Nago Island where they feed on seagrass. At other times, hunting for turtles takes place around the patch reef between Nago and Atmago. Nests are raided for eggs at Nago, Atmago, and Ral. This is happening in other parts of the Tigak Islands and New Ireland Province but there is not sufficient information on this.

According to one immigrant from Manus now living in Kavieng, hunting for turtles is done both during the day and at night. The best time for hunting turtles is at high tide during daylight. In seagrass meadows, the best time for catching turtles is early in the morning when turtles are feeding. During high tide, turtles come up to shallower waters and rest under reef boulders, this behaviour makes them easy to be caught by spear fisherman.

Turtles are also caught when they come ashore to lay eggs. Some fishermen catch turtles using spear guns while diving; in recent years fishermen have been using harpoons from powered outboards. Turtles are sometimes caught while they are mating at sea. The authors of this review witnessed on rare occasions at the Kavieng market, that turtles were sold in pieces, either fresh or smoked, while raw eggs (on two occasions observed) were sold raw in heaps of five for PGK 1.00. Turtle pieces were sold for between PGK 5.00–10.00, depending on size. Small, live turtles are sometime sold for PGK10.00 and PGK 20.00, depending on size.

Nesting beaches are found throughout the province. Villagers around Kavieng stated that turtles, especially green turtles near Kavieng, are thought to nest during August, September and October. Wright et al. (1983) report that leatherback turtles nest in southeastern New Ireland and in the northern Tigak Islands between September and January. Kulmoi and Vui (1989) also report that turtles at the southern tip of New Ireland nest from July to September. This may be the same nesting leatherback turtle population that Wright et al. (1983) describe above.

Two known leatherback nesting beaches are at Wettin Valley and at Lihir. The one at Lihir (Kiapit Beach), however, is being destroyed by waste from the gold mine. Around Kavieng, green turtles are known to nest at Nago Island, Atmago, Nusalaman, Usen and Lemus. People from Limanak, Limalam and Nusailas Islands say that in the past green turtles used to go ashore to nest. Turtles no longer use these beaches, however, and this may be attributed to the increase in human population on these islands which led to the slaughtering of the turtles when they came ashore to nest.

Unconfirmed reports from Mussau and Emirau Islands in the St. Mathias Group indicate that turtles nest there. Very few people there eat turtles because the islanders are followers of the Seventh Day Adventist church. However, people from Kavieng and Manus who visit the islands, slaughter turtles to take back home. On one occasion, a passenger vessel travelling back to Manus from Emirau loaded seven green turtles.

Management

All marine turtles are listed on Appendix 1 of CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora), means that international trade in turtle species and their products is prohibited. Papua New Guinea is a signatory to the Convention.

Turtles are highly migratory; a PNG turtle may travel to Fiji to mate and then return to PNG to nest. Management of turtles needs to take this into account and collaboration between various in-country agencies is necessary.

Immediate steps to take now may include:

- Protection of nesting beaches, which would also involve the wise use of beaches, and properly planned coastal developments that may pose danger to nesting female turtles and their hatchlings.
- Consideration should be given to size restrictions of hunted turtles (turtles take between 20 and 50 years to reach sexually maturity).

SILVER FISH

Resource

Silverfish, or rosy thread-fin bream (*Nemipterus furcosus*), inhabit most lagoon areas in and around Kavieng harbour, and prefer a benthic habitat of mixed silt and sand. In Kavieng, this fish inhabits depths from 10–45 m (Chapau, 1993).

Fishery

Silverfish are caught by hook-and-line using very light gear (e.g. 10 lb monofilament line with very small hooks). The fish are baited with tuna, mainly *Euthynnus affinis*. Sometimes squid, scads and sardines are used. Chapau (1993) gives a full description of where the fishery operates.

Silverfish are mainly harvested for commercial purposes. On many occasions, they are sold at roadside stalls along Bagail Village. Because of their small size they are sold in strings five pieces and sold for PGK 1.00 per string. The fish are not processed for sale, and are sold with guts and gills.

Silverfish made up 90% of all handline catches during a nine-month study period (Chapau, 1993) conducted in Kavieng harbour. The catch rates averaged at 2.99 kg/line.hr, from January to March. This catch rate then declined thereafter.

Estimates of biomass (Chapau, 1993), ranged from 3.9 to 5.2 t per year or an abundance of 41,000 to 54,000 pieces of bream each year covering 2000 hectares. Comparing this study with others Chapau (1993) concludes the current catch rates are underestimated.

Current status

The fishery has historically operated year round, although catch rates are highest during the first four months of the year when the larger size *Nemipterus furcosus* are caught from canoes and banana boat in the Nusa Channel near Kavieng. Fishing for this species is normally done during the day, although they are sometimes caught at night.

Currently there is no targeted fishing for silverfish. Fishing effort is focussed elsewhere (i.e. in reef fishing or trolling).

Management

No management guidelines are in place for this fishery. However, residents from Bagail call this fishery 'a last chance fishery' where they will only exploit the fishery when needed. Any detailed management of the resource will require an in-depth investigation of stocks.

GIANT CLAMS

Resource

New Irelanders call all giant clam species, garam sel. The following giant clam species are found in New Ireland waters: horse hoof (*Hippopus hippopus*), boring clam (*Tridacna crocea*), smooth giant clam (*T. derasa*), giant clam (*T. gigas*), great clam (*T. maxima*), and the fluted clam (*T. squamosa*). These clams inhabit a wide variety of habitats including coral reefs, lagoons, sandy bottom habitats, seagrass areas and open intertidal areas.

Fishery

All giant clam species are harvested for household and sometimes commercial use in many parts of New Ireland, especially the Tikana area, Djaul and New Hanover. Evidence of high exploitation can be observed in villages where there are high numbers of fresh empty giant clam shells present in the village or on the reefs.

Occasionally, boring clams and smaller horse hoof clams are sold at the market as smoked product for PGK 0.50 per string or as an ingredient in the casawa (tapiok) and sago sold at the Kavieng market, for PGK 0.30–0.50.

Hippopus hippopus and *Tridacna crocea* have been periodically harvested for commercial use from parts of northern New Hanover, Tigak and Djaul. The sales of these clams are mainly from the Tigak Islanders.

Both men and women harvest giant clams. Women are also involved in the preparation of the casawa that is mixed with the clams. Men are specifically involved in diving for clams that are deeper than that which the women are able to harvest.

Current status

The general assumption is that there is widespread overfishing of clams in recent years on nearshore reefs.

There are unconfirmed reports of poaching in parts of New Ireland, especially in the remote reefs, by foreign vessels that target clam muscles. In Kavieng harbour, crews from purse seiners were reportedly using iron bars to extract the boring clam from reefs around Nusa Island. It is unclear if any of the poachers were prosecuted.

Management

All giant clam species are listed on Appendix II of CITES. This means the trade of this species is prohibited unless it is shown the products came from farmed stocks or were harvested from a managed area and its trade will not affect natural populations.

In PNG, sedentary resources (such as giant clams) cannot be harvested at night by using any type of light. However, this is not being enforced.

MANGROVES

A variety of mangrove species are present in the province. Mangroves contribute to the productivity of shallow waters, especially around Kavieng (Balgai Bay, Tigak Islands and New Hanover). Mangroves are also found in other parts of New Ireland, but not in as large an area. The total area of mangroves in New Ireland is estimated to be 15,000 ha (Wright et al., 1983)

Direct benefits obtained from mangroves include firewood and timber for building. The fruit of one species of mangrove is used as a "sweetener" by some people around New Hanover to mix with sago. In Mussau and Emirau Islands in the St. Mathias Group, people eat the fruit of another mangrove species, while on Tabar Island, the fruit of yet another species of mangrove is chewed as betel nut. Mussau and Emirau people do not mix the fruit with other food items as do people from New Hanover, but instead eat it directly after a curing process, involving boiling, soaking, drying and mashing.

Indirectly, mangroves act as buffers to protect shorelines from storm winds and waves, and trap sediments that may otherwise wash onto coral reefs, killing the coral polyps. Mangroves also provide suitable habitats and nursery areas for a large and varied number of animals that make up a substantial portion of people's subsistence diet. Furthermore, mangroves provide artisanal and commercial opportunities for New Irelanders.

Commercial uses of mangroves came around the 1970s and early 1980s when the Nago Island Katsuobushi factory was operating. Wright et al. (1983) reported that up to 100 t, at a purchase price of PGK 19/t/month was used by the factory to smoke skip jack tuna. The beche-de-mer fishery also uses considerable amounts of mangrove wood as fuel for processing.

SEAGRASSES

Seagrasses are ranked with coral reefs and mangroves as some of the world's most productive habitats (Short et al., 2003). Thirteen species of seagrasses have been described in Papua New Guinea (Fortes, 1990).

Coastal seagrasses are food for turtles, hundreds of fish species, and dugongs. Seagrasses also filter nutrients and contaminants from the water, stabilise sediments, and act to dampen water currents. Cultural or culinary uses of seagrass is not known in New Ireland. In Manus, people eat the fruits of one species of seagrass.

Seven species of seagrass have been identified in the area with a possible three yet to be identified. This may bring the number of seagrass species in New Ireland to 10. Species identified in the Kavieng areas are: *Enhalis acoroides*, *Thalassia hemprichii*, *Cymodocea rotundata*, *C. serrulata*, *Halodule uninervis*, *Halophila ovalis* and *Syringodium isoetifolium*.

Monitoring

Seagrasses in Kavieng have or are being monitored using two monitoring protocols, SeagrassNet and Seagrass Watch. SeagrassNet has a scientific approach compared with Seagrass Watch, a community-based orientated monitoring protocol.

The main objective of the seagrass monitoring initiative, which is part of a global seagrass network, is to monitor the general health of seagrasses.

SeagrassNet sites established in Kavieng are at Nusalik Island, Siwasat Point and at Lemus Island. The Lemus Island site was discontinued due to too long travel distance. At these three sites, three permanent transects are set horizontal to the beach and marked with permanent pegs. Monitoring occurs on a quarterly basis.

In SeagrassNet, the major difference in monitoring protocol with Seagrass Watch is the measurement of light intensity and water temperature in the seagrass meadows. At randomly selected locations along a 100-m transect, 12 x 50 cm x 50 cm quadrats are monitored for each of the three permanent cross-transects. At each quadrat, species composition, percentage cover of each species represented in the quadrat, and canopy height of the dominant species are recorded. Observations are made on the presence and absence of grazing, and a photograph of each quadrat is taken along with a biomass sample on the opposite side of the quadrat. These samples are further processed and sent to the University of New Hampshire, USA for analysis. At each midsection of the three cross-transects, a sediment sample is taken. This is also sent to the USA including an herbarium press. Other parameters (such as water depth and salinity) are also recorded.

Seagrass Watch has been established in a number of communities in New Ireland. Sites monitored are at Lavongai (New Hanover, 2 sites), Mongop High School (East Coast New Ireland mainland, 2 sites), Bol Village (East Coast New Ireland mainland 1 site), Panamecho Village (West Coast New Ireland mainland, 1 site), Panapai (near Kavieng, 1 site). In these communities, people are trained to do monitoring. Monitoring is not restricted to a quarterly approach as is done with SeagrassNet, but it is advisable to monitor more frequently than quarterly.

Seagrass Watch monitors for species composition, and percentage cover by percentage, grazing, canopy height and sediment type is observed and recorded. Counts of animals in the quadrats are also recorded and the presence and absence of algae by percentage cover within the quadrat. Three permanent transects are set perpendicular to the beach and monitored.

CORAL REEFS

Plans to monitor the general health of coral reefs in New Ireland have not eventuated. However, meetings with island communities in Tigak, New Hanover, West Coast New Ireland and Central New Ireland have been conducted about monitoring plans, and support for implementation of this monitoring has been overwhelming.

Pre-surveys have been conducted in some sites (Lemus Island, Eruk Island, Nago Island, Siwasat point and Lavongai Village on southern New Hanover). In some areas, dead corals (due to past dynamiting) have been observed which in some instances accounted for more than 60% dead corals in areas pre-surveyed. Also observed in these areas were 100% death to coral colony (Lemus Island).

At Eruk Island, it was observed that *Acropora* corals were uprooted along the slope. This is due to considerable wave action in that area.

Monitoring

Coral reef monitoring in New Ireland will be done according to the following the Reef Check methodology, although the Australian Institute of Marine Science (AIMS) naming of coral species will be used.

Transects will be set parallel to reef crest and two permanent transects, one at 3 m and another at 10 m will be monitored. Reef Check methodology includes the counting of fish and sedentary resources along the same transect with emphasis on indicator

species. However, for New Ireland purposes, all species will be monitored including indicator species.

No monitoring has been undertaken as yet but will be and corals will be included as a monitoring parameter especially in the LMMAs (discussed below) in New Ireland Province.

LOCALLY MANAGED MARINE AREAS

LMMAs are scattered around the province, as shown in Table 5. These are reefs area closed from fishing and other fisheries related activities normally used for subsistence purposes. The areas vary in size and the duration of closure is depended on the reason for the closure. New Irelanders refer to these areas as tambu areas (no fishing). Some of the closed areas are permanent while others are temporary and are not always closed for resource or marine environment protection or conservation. Marine resources and the environment are protected as a consequence. Some elders, however, have or are closing off reef areas for resource protection, not so much for marine environments.

Table 6: Established and proposed locally managed marine areas in the Kavieng area

Village	Area	Reef Ownership	Status
Madina	Kavieng, East Coast	Individual	Current
Panamecho	Kavieng, West Coast	Family	Current
Luapul	Kavieng, East Coast	Family	Current
Lissenung	Kavieng, Tigak Island	Dive Resort	Current
Lakarol	Kavieng, East Coast	Clan	Current
Lemus Island	Kavieng, Tigak Island	Individual	Current
Nago Island	Kavieng, Tigak Islands	Family	Current
Patio Island	Kavieng, Tigak Island	Individual	Current
Nusaum Island	Kavieng, Tigak Island	Individual	Current
Lak	Namatanai East Coast	Clan	Current
Laburua	Kavieng, East Coast	Family	Current
Kaplaman	Kavieng, East Coast	Community	Proposed
Tsoi Laung	North New Hanover	Family	Proposed
Mumu Island	Namatanai, East Coast	Community	Proposed
Sosson Island	West New Hanover	Family	Proposed
Lavongai	South New Hanover	Community	Proposed
Eucha Patch	Kavieng	Community	Proposed
Stephen Strait	Tigak Islands	Community	Proposed
Usen Island	Tigak Islands	Family	Proposed

Aini (2002) discusses these closures in New Ireland and has suggested the need for institutionalising and strengthening these tambu areas. Traditional closure enforcement systems and tambu areas are facing threat of not continuing or being practised. This is attributed to the current degradation of leadership and chief hierarchy systems in most communities and also lack of respect for community leaders, chiefs and the elderly (Aini, 2002)

Monitoring

No monitoring of these tambu areas has so far been conducted, except for community awareness and consultative meetings with communities, clan members, family members and individuals. However monitoring is planned for the future, and will concentrate on collecting baseline data for fisheries and marine resources and basic mapping of areas concerned. These will include seagrasses, coral reefs, sedentary resources (giant clams, lobsters, trochus, sea cucumbers) and spawning aggregations.

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APPENDIX 1. NEW IRELAND PROVINCE POPULATION DETAILS

Local Level Government Area	Households	Males	Females	Total
Murat	850	1,799	1,794	3,593
Lavongai	3,863	9,414	8,869	18,283
Tikana	4,275	10,842	9,429	20,271
Kavieng Urban	2,310	6,116	5,158	11,279
Namatanai Rural	4,093	9,509	8,480	17,989
Central New Ireland	3,688	9,604	8,248	17,852
Konoagil	1,579	4,353	3,804	8,157
Tanir	1,613	4,172	4,188	8,360
Nimamar	2,382	6,951	5,620	12,571
TOTAL	24,753	62,760	55,590	118,350

APPENDIX 2. DEEP-SEA FISH SPECIES HARVESTED IN KAVIENG

Family/Species	Common name
Lutjanidae/Snappers	
<i>Etelis carbunculus</i>	Short-tailed red snapper
<i>E. corascans</i>	Long-tailed red snapper
<i>E. radiosus</i>	Short-tailed ruby snapper
<i>Pristipomoides multidens</i>	Large-scaled jobfish
<i>P. flavippinis</i>	
<i>P. filamentosus</i>	Rosy jobfish
<i>P. zonatus</i>	Banded power snapper
<i>P. sieboldi</i>	
<i>Lipocheilus carnolabrum</i>	
<i>Lutjanus bohar</i>	Red bass
<i>L. malabaricus</i>	Scarlet seaperch
<i>L. timorensis</i>	Scarlet seaperch
<i>Aphareus rutilens</i>	Silver jaw job-fish
<i>Paracaesio stonei</i>	Stone's snapper
<i>P. kusakarii</i>	Kusakar's snapper
Serranidae/Cods	
<i>Epinephelus septemfasciatus</i>	
<i>E. chlorostigma</i>	
<i>E. morrhuia</i>	Snake skin rock cod
<i>E. magniscuttis</i>	Brown spot rock cod
<i>Variola louti</i>	Lunar tailed cod
Carangidae/Deepwater jacks	
<i>Seriola purpuracens</i>	
<i>S. rivoliana</i>	
<i>Caranx lugrubis</i>	

APPENDIX 3. BECHE-DE-MER SPECIES HARVESTED IN KAVIENG

Scientific name	Common name
<i>Thelenota anax</i>	Amberfish
<i>Holothuria atra</i>	Black fish
<i>Holothuria nobilis</i>	Black teat fish
<i>Bohadschia vitiensis</i>	Brown sand fish
<i>Bohadschia marmorata</i>	Chalk fish
<i>Stichopus variegatus</i>	Curry fish
<i>Actinopyga echinites</i>	Deepwater redfish
<i>Holothuria fuscopunctata</i>	Elephant's trunk fish
	Flower fish
	Giant beche-de-mer
	Golden sand fish
<i>Stichopus chloronotus</i>	Green fish
<i>Bohadschia argus</i>	Leopard fish
	Lolly fish
	Mixed beche-de-mer
<i>Holothuria edulus</i>	Pink fish
<i>Thelenota ananas</i>	Prickly red fish
<i>Actinopyga miliaris</i>	Surf Red fish
<i>Holothuria scabra</i>	Sand fish
	Snake fish
<i>Actinopyga lecanora</i>	Stone fish
<i>Holothuria nobilis</i>	White teat fish
	Yellow fish

APPENDIX 4. LIVE REEF FOOD FISH SPECIES HARVESTED IN NEW IRELAND PROVINCE

Scientific name	Common name
Serranidae	
<i>Epinephelus fuscoguttatus</i>	Flowery cod
<i>E. malabaricus</i>	Malabar cod
<i>E. polyphemus</i>	Marbled cod
<i>E. corallicola</i>	
<i>E. cyanopodus</i>	Speckled cod
<i>E. cholorostigma</i>	Brown spotted cod
<i>E. lanceolatus</i>	Giant cod
<i>Plectropomus areolatus</i>	Squaretail coral trout
<i>P. maculatus</i>	Bar cheeked coral trout
<i>P. laevis</i>	Footballer coral trout
<i>P. oligacanthus*</i>	
<i>Cephalopholis miniata</i>	Coral grouper
<i>C. miniata*</i>	
<i>C. serrata*</i>	
<i>Variola louti</i>	Coronation trout
<i>Cromileptis altivelis</i>	Barramundi cod
<i>Anypseradon leucogrammicus</i>	White lined grouper
<i>Athaloperca rogaa</i>	Redmouth grouper
Lutjanidae	
<i>Lutjanus bohar</i>	Red bass
<i>L. semicinctus</i>	Half barred snapper
<i>L. gibbus</i>	Paddle tailed snapper
<i>L. monostigma</i>	Onespot snapper
<i>L. vitta</i>	One line snapper
<i>L. carponotatus</i>	Stripey seaperch
<i>L. rivulatus</i>	Scribbled snapper
<i>L. fulvus</i>	Flametail snapper
Carangidae	
<i>Caranx lugubris</i>	Black trevally
Lethrinidae	
<i>Lethrinus elongatus</i>	Long-nosed emperor
<i>L. lentjan</i>	Redspot snapper
Labridae	
<i>Cheilinus undulates</i>	Humpheaded moari wrasse
Scorpaenidae	
<i>Synanceia verrucosa</i>	Reef stone fish

Source: Aini and Hair, 1995