

**STATUS REPORT: NEARSHORE AND REEF
FISHERIES AND AQUACULTURE**

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Status of Fisheries

Coastal Fisheries: Nearshore and Reef Fisheries and Aquaculture

Introduction

Coastal fisheries are brought up for information in order to help address the complete portfolio of issues that Pacific Island Fisheries Ministers have to deal with in their everyday work, beyond the commercial tuna fisheries that FFC normally confines its business to.

Commercial tuna fisheries continue to be of primary significance to Ministers at the regional level because tuna are highly migratory fishes with a regional range – industrial tuna fishing fleets are likewise international in their range – and tuna fisheries require, both legally and practically, regional cooperation if they are to be managed effectively. However, although Coastal Fisheries in the islands do not usually have the same transboundary scope, the management and conservation of these fisheries benefits greatly from regional intercommunication, access to a shared regional support service, and by comparing experiences directly in meetings like this. Coastal fisheries cause at least as many day-to-day management headaches for Ministers and government officials as tuna fisheries.

Commercial tuna fisheries are a major contributor to revenue and national economic development, while coastal fisheries are a major source of national food security and rural income. Although reliable overview estimates are difficult to come by, it is likely that oceanic fisheries and coastal fisheries are currently approximately equivalent in economic importance to island countries, taking the island region as a whole, and counting benefits in terms of import substitution and livelihoods as well as cash. The main difference (apart from the different transboundary implications mentioned above) is that tuna fisheries are relatively new and still have considerable potential for further development – not so much in expansion of the total catch as expansion of the Pacific Island share in the catching and processing sectors – while the coastal fisheries (apart from aquaculture – see later) are age-old and do not, as a rule, have further commercial development potential. Coastal fisheries are “mature” in fishery development terms, and the main focus with reef fisheries is on consolidation and protection of current benefit. If anything, the main prospects for economic and livelihood development from reef resources, over and above maintaining current levels of production, lie not in fisheries, but in tourism and other non-extractive uses.

Pacific Island societies are unusually dependent upon fisheries for their protein nutrition, compared to other societies, and subsistence access to reef and nearshore pelagic fisheries is one of the primary reasons for the generally good nutritional status of coastal Pacific Island people. Fish consumption averaged across the countries of the region is in the order of 65 kg per head per year¹ (ranging from a low of 17 to a high of 110kg), compared to around 8 kg in Africa and around 25 kg in North America. The overall global average consumption of fish per capita per annum is around 16kg².

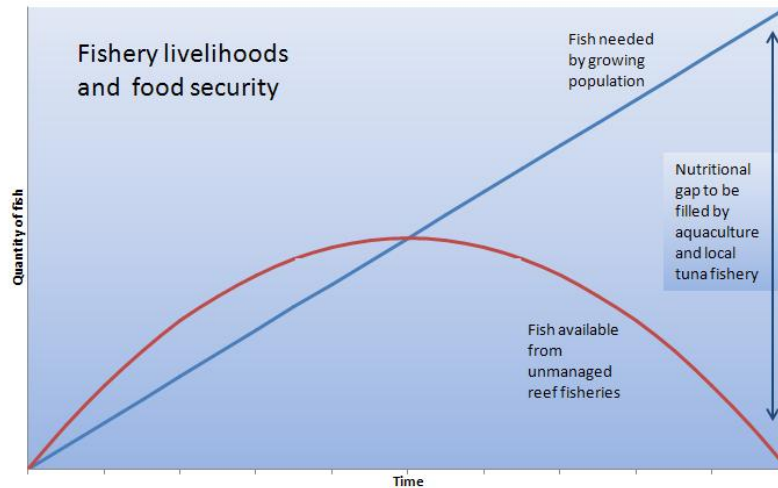
These Pacific island food fish are mainly caught locally, from coastal and nearshore fisheries. However, risks to this supply are growing. Human populations are increasing overall, and this increase is disproportionately concentrated in capitals and nearby fishing grounds, which are also more impacted by non-fishing related stressors. The need to sustain families through paid

¹ Preliminary unpublished figure from SPC Reef Fisheries Observatory data

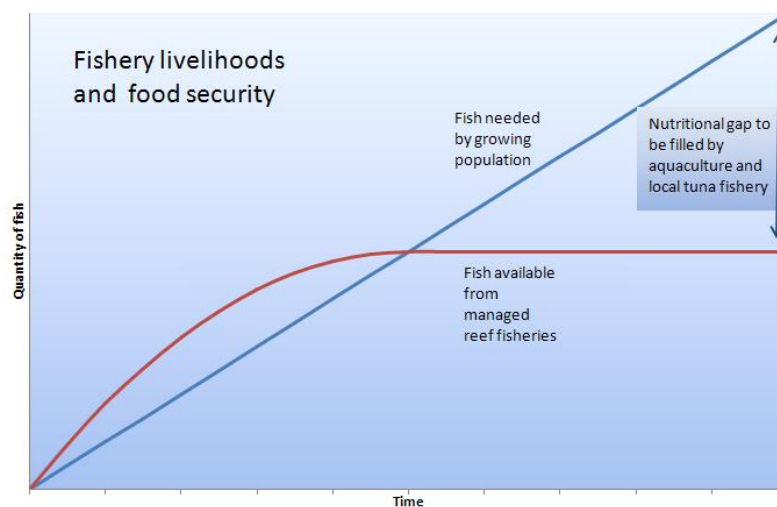
² FAO State of World Fisheries and Aquaculture report (http://www.fao.org/sof/sofia/index_en.htm)

employment rather than through subsistence agriculture and fishing is weakening traditional mechanisms of resource husbandry.

The risk to food security is a gradually increasing, medium to long-term worry in most places, as the gap opens up between the increasing nutritional needs of increasing populations and the finite production capacity of natural coastal fisheries ecosystems – capacity which will actually reduce if overfishing and pollution are significant.



(a) The “food gap” with unmanaged reef fisheries or increasingly polluted reef ecosystems



(b) The “food gap” with managed reef fisheries

The potential future gap between local food fishery production capacity and future local food fish requirements (see notional diagram above) can be addressed:

- a) by trying to prevent a decline in the “bottom line” – by maintaining the production of coastal ecosystems through good management of fisheries and the mitigation of urban impacts and;
- b) by trying to increase the “top line” – by gradually diverting some of the vast surplus (in Pacific island national production/consumption terms) of Pacific Island EEZ tuna production away from export and into local nutrition, and by developing low-cost fish production methods

that are less dependent on the natural carrying capacity of natural marine ecosystems, particularly freshwater pond fish-farming.

There are also much more immediate coastal fishery worries, and these are mainly in the fully commercialized coastal fisheries, particularly the export fisheries, some of which are already suffering from severe overexploitation (with some very vulnerable resources – such as the larger species of giant clam – hovering on the verge of extinction). Most of these coastal export fisheries are the focus of, or are in need of specific, immediate management action, either to conserve their biological status or recover their potential value, and in some cases this action could involve collaboration between different islands and countries – a regionally-harmonised level of information-sharing and decision-making.

Actions have taken place, or are being developed, on all of these fronts. For example:

- developing the technical and policy foundations for freshwater aquaculture;
- domestication of commercial tuna fisheries and development of artisanal tuna fishing, including via coastal, tethered, fish aggregating devices (FADs);
- recognizing that management of reef food-fisheries in the Pacific Islands is most effective when traditional and community marine tenure systems and local knowledge are taken into account;
- coastal fisheries management planning using both community and ecosystem approaches;
- providing information support for strong management actions by countries in some coastal export fisheries, such as national moratoria on bêche-de-mer exports to effectively promote stock recovery, short open-seasons for trochus fisheries with tight monitoring to ensure maximum long-term commercial benefit etc.
- developing a framework for a regional level of coastal export fisheries management and marketing coordination.

All of these activities are aligned with ongoing regional training, information and resource assessment programmes, and there is also a special stream of regional activities aimed specifically at economic and livelihood development in those coastal fields which are amenable to such development, particularly nearshore pelagic fisheries and mariculture.

However, this is not an institutional report about work that is ongoing or planned. The main aim of this report is to present a first overview of the status of Pacific Island coastal fisheries themselves. It will necessarily be an outline report in the first instance, based on the best available scientific information (with the emphasis currently on the “available” rather than the “best”). Coastal fisheries are complex – usually involving upward of 100 fin-fish species and dozens of invertebrates and comparatively little investment has been made in understanding, or even monitoring them. We are only just at the stage of developing baselines for future assessment, and it is likely to be several project cycles before we are in a position to deliver the kind of comprehensive opinions about the status of coastal fisheries across the region as we are currently able to do for tuna fisheries. The following report is thus based upon a range of local scientific investigations coupled with a broad-scale understanding of the region gained from the many person-years of experience acquired by the Coastal Fisheries Programme in visiting all of SPC/FFA island member countries.

The idea of a regional report on the status of coastal fisheries is not new. SPC presented the first such report at the 1994 Regional Technical Meeting on Fisheries³, and followed this up with an expanded version published in the Review of Oceanography and Marine Biology in 1996⁴. However, most SPC members do not collect statistics on artisanal fisheries – there was not enough information flow from members to support an annual regional update and the termination of UK funding support to the SPC Coastal Fisheries Observatory in 1998 put a temporary stop to any regional attempts to fill the gap. The EU-funded “Pacific Regional Oceanic and Coastal Fisheries Development Programme” project (later dubbed “PROCFISH”) picked up the ball again, but because of its in-depth, one-country-at-a-time approach, it has not been possible to start producing a regional status report until all the baseline surveys had been completed, this year.

This preliminary report includes some of the first regional-level information that is starting to emerge from the analysis of all those local surveys. With the EU reef fisheries survey funding about to finish, it is sincerely hoped that regional coastal fisheries status-reporting does not stall again.

Reef fisheries

By “reef fisheries” we mean fisheries for organisms associated with tropical coral reefs and lagoons – essentially fisheries taking place in Pacific Island waters from 0-50m depth. These are the main food-fisheries of the Pacific as well as supplying the main non-tuna export fisheries – usually non-perishable invertebrate commodities like trochus shell and bêche-de-mer (dried sea cucumber) but also an increasing amount of finfish, including high-value fish and invertebrates exported alive for food and aquaria. Pacific Island reef fisheries are commercialized to different extents in different countries, but these are mainly artisanal and subsistence fisheries, without much full-time involvement by professional fishers.

Fishing pressure on reef fisheries

There have been several limited-area studies of yields and fishing pressure on Pacific Island reef fisheries, including a review by SPC in 1996⁵, but this is the first time that a survey has been extended across 17 island groups in the Pacific, and the data being analysed at the moment are yielding valuable insights. The following table is a simple summary and only applies to the median of the 4-6 surveyed sites in each country or island group – it will require analysis in relation to broad-scale national census and household survey data before any firm conclusions can be reached about the whole country. However, the preliminary analysis is useful to illustrate the general range of fishing pressure on reef fisheries.

³ <http://www.spc.int/coastfish/reports/rtmf25/WP8-RTMF25.pdf>

⁴ http://www.spc.int/coastfish/Reports/ICFMAP/Dalzell_96_OMB.pdf

⁵ <http://www.spc.int/mrd/ministers/pantext3.pdf>

Country	people/km ² reef area at surveyed sites	fishers/km ² reef area	total catch t/year/km ² reef	subsistence catch t/year/km ² reef	externally sold catch t/year/km ² total reef
Cook islands	86.1	17.7	3.3	4.0	0.4
French Polynesia	11.6	3.5	14.0	0.6	9.2
Kiribati	47.0	9.1	17.1	4.6	13.7
New Caledonia	4.2	1.6	0.3	0.1	0.3
Niue	118.3	34.7	3.8	3.5	0.3
Palau	5.3	1.1	0.8	0.3	0.5
PNG	27.3	12.3	5.5	0.7	4.8
Tuvalu	149.3	38.5	42.5	19.7	17.0
Vanuatu	52.4	19.8	5.5	1.0	4.5
Wallis & Futuna	13.8	3.3	2.2	0.8	1.4
Yap-FSM	23.3	5.7	3.0	1.0	2.0

It is notable that certain fishing grounds in the Pacific Islands appear to have far higher fishing effort, and produce far higher catches than others. In fact the differences in production per unit area are remarkable. However, when viewed in conjunction with the underwater surveys of fish and invertebrate stocks it is clear that this difference in production is at least as much due to huge differences in fishing effort as differences in the status of resources or of habitats. It should also be noted that summarising total catches and effort in this way obscures the different status and contribution of individual species or species groups. A more detailed analysis is still to come.

The main question to be answered is: “have these catches been sustained over time” and, ultimately, “what level of reef fishing effort is in fact *sustainable* in different habitats”. The current Reef Fisheries Observatory survey cannot definitively answer these questions immediately. The range of results in the current snapshot dataset will give an indication of the possible answer, but this has to be validated against a time-series of information – the same kind of long-term information that our tuna fisheries assessments use. This has been a baseline reef fisheries survey, to be followed up in future using comparable methodologies, at the same sites, in order to begin to answer those fundamental questions, and to build up the long-term information base.

We can however draw some conclusions about reef fishery sustainability from a “snapshot” survey by comparing different areas where the different contributing factors can be isolated and measured. This broad-scale analysis is just beginning now that all the individual site surveys have been compiled, and will be presented in future reports.

Status of reef food fisheries:

(a) Dependence on reef food fisheries

The following table contains some of the results of recent household and field surveys by the SPC Reef Fisheries Observatory across the region to illustrate the high involvement of rural people in fisheries.

Proviso: *It is important to note that this information comes from 4-6 representative fishing grounds in each country and is not necessarily representative of the whole country, since the population is unevenly concentrated and people living in urban centres are likely to be under-represented. It is also important to note that the size of communities surveyed, geomorphology of islands, degree of urbanization/traditional lifestyle are highly variable between communities in any one country surveyed as well as between countries compared. This information will need to be analysed in the context of country-wide national census and household survey information before reliable comparisons can be made between countries.*

This preliminary analysis is however useful for illustrating the general nature and degree of dependency on reef and lagoon resources of **coastal rural communities** across the region, using comparable methodologies at each site.

Dependency on Reef and Lagoon Resources

Country	percent of household (HH) with fishers	average number of fishers/HH	per capita consumption of fresh fish kg/year	per capita consumption of invertebrates kg edible meat/year	1st income from fisheries (% of HH)	2nd income from fisheries (% of HH)	No income from fisheries (% of HH)
Cook Islands	85	1.8	62.4	3.4	5	4	75
Fiji	100	2.3	105.8	9.6	76	23	0
French Polynesia	88	1.6	59.9	2.0	12	11	74
FSM-Chuuk	100	4.6	79.6	16.1	96	0	4
FSM-Yap	95	1.9	45.5	6.6	0	9	77
Kiribati	94	2.0	111.4	1.9	30	30	40
Marshall Islands	98	2.7	114.4	5.5	20	15	24
Nauru	97	3.7	45.6	1.5	5	17	77
New Caledonia	98	1.5	28.4	6.6	13	20	70
Niue	75	1.3	30.3	2.5	1	9	84
Palau	79	1.2	59.8	6.4	10	17	65
Papua New Guinea	100	2.6	35.4	7.6	50	30	13
Samoa	88	1.8	54.8	11.0	24	26	43
Solomon Islands	99	3.0	105.7	8.0	28	32	27
Tonga	56	1.2	62.6	3.7	37	10	56
Tuvalu	100	2.0	134.6	4.1	25	24	47
Vanuatu	100	2.9	17.4	3.7	22	42	28
Wallis And Futuna	94	1.7	47.9	3.7	28	28	49

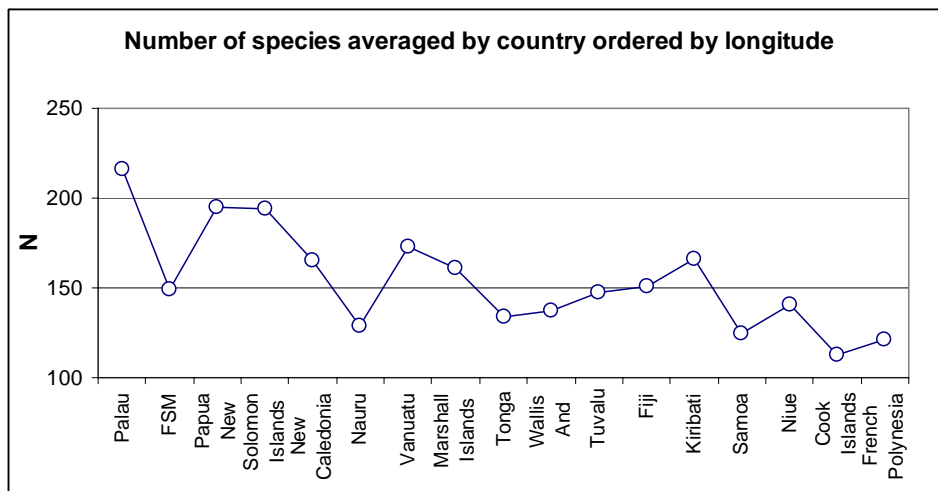
The last three columns above provide an indication of the dependency of rural families on income from fisheries. At some sites, fishing is the only, or major source of income – fishing provides both cash and food. At other sites, other sources of income are available and fishing provides mainly for family food. In a few countries total fish consumption is relatively low, and fishing is not as important as agriculture for nutrition, but even at these sites a quarter of households, or more, derive most of their cash income from fishing.

At all Pacific Island sites fish consumption is above the global average – usually considerably above.

This table also provides an indication of the relative importance of finfish and invertebrates in everyday nutrition. Invertebrate food preparation is much more time consuming, and thus getting less attractive and common, in particular if changes towards a more “urban” lifestyle is taking place. However, invertebrate fisheries are more significant for their export and cash value, and for nutrition following natural disasters. It should also be noted that a proportion of the invertebrate catch is probably consumed *in situ* – while fishing on the reef – and thus not included in our household survey data.

(b) Status of reef finfisheries

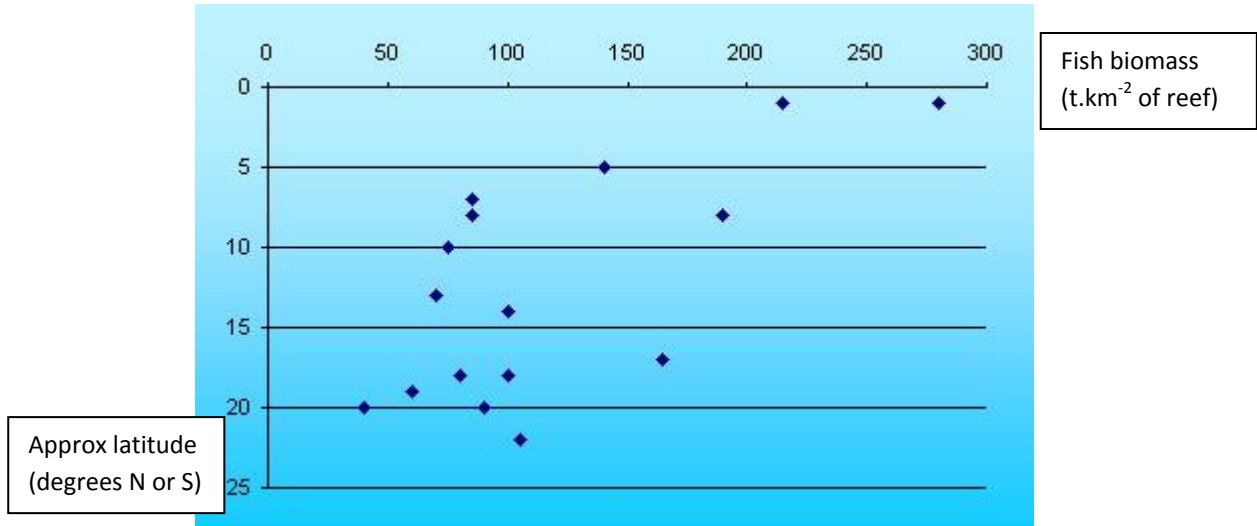
In the west of the region, in Palau or Papua New Guinea, over 100 species can be regularly landed in fish markets, while in eastern Polynesia there are fewer species to be found. Marine species biodiversity declines from west to east, illustrated by the following data on reef fishery species numbers observed by the SPC Reef Fisheries Observatory during the course of fieldwork in different countries. Invertebrates show the same biodiversity trend from west to east, but there are generally fewer invertebrate than fish species landed for food



This is not to say that individual reef fish are less numerous or reefs less prolific in the east than the west, but that a similar biomass may be provided by fewer species in the east. SPC surveys suggest that the total biomass of fishable reef finfish bears no particular correlation to the number of species present. A preliminary regional analysis suggests that the average standing biomass of fishable reef fish across the region is currently in the order of 100 grams of fish per square metre⁶ of reef, but this figure is very variable by site, ranging from a high of nearly 300 g.m⁻² to a low of less than 50 g.m⁻².

⁶ Grams per square metre is equivalent to tonnes per square kilometre

Per-country average biomass of reef fish plotted against approximate latitude of country



These variations in fishable reef fish biomass are not obviously correlated with differences in apparent fishing pressure, indeed at first glance reef fish biomass appears to have some correlation with latitude – the 2 countries with the highest biomass per unit area of reef fish are both close to the equator, in year-round warm waters.

However, it is too early yet to draw any firm conclusions. The SPC Reef Fisheries Observatory (RFO) is currently working the huge amount of data that has been collected over the past 5–6 years in field surveys across the region to try and unravel the relative effects of fishing, of other human influences, and of oceanography on reef fish biomass.

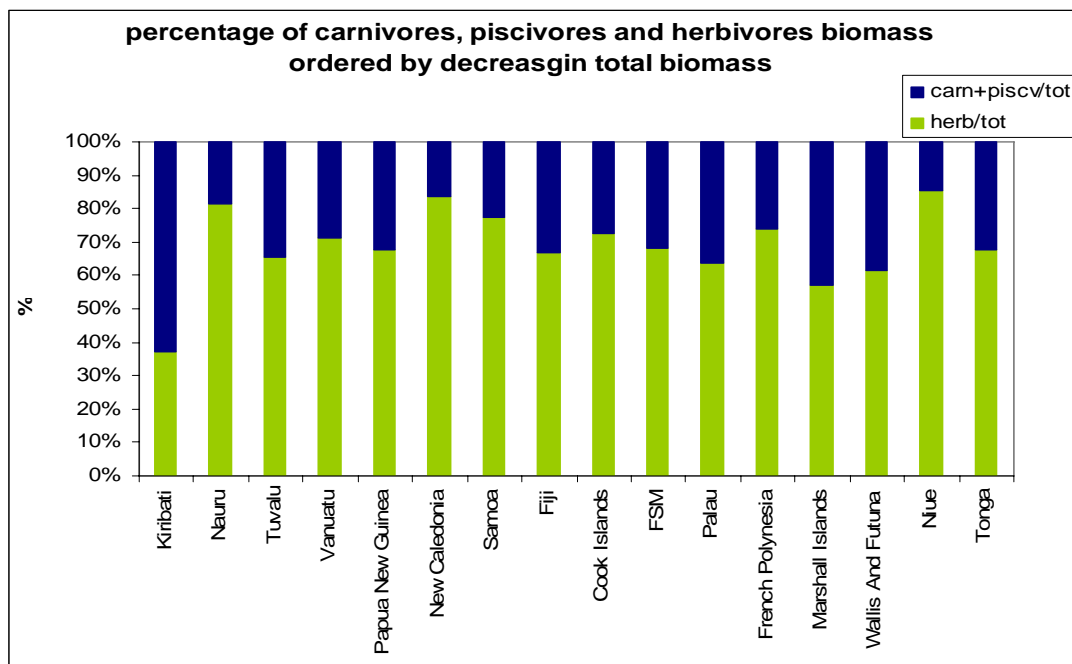
If we want to measure fishing pressures and exploitation rates on that standing biomass of reef fish, it is not possible to use the same methodologies that we use for tuna fisheries – vessel logsheets, port unloadings, exports, and tagging – at least not to anywhere near the same extent. With reef fish, hundreds of species are landed at thousands of points from many thousands of boats and individual fishers throughout the islands, and most are consumed within a few kilometres of capture and don't even enter the cash economy. Instead we must rely on occasional samples of landed catches, family consumption surveys, vessel and gear counts, and questionnaires, supplemented by occasional logsheet and sales data from the few commercial fisheries that compile records.

We are still a long way from being able to estimate **fishing mortality** in reef fisheries as we do in tuna fisheries, and because most governments and fishing communities do not collect information from fishers we're even a long way from being able to estimate **fishing effort**. However, by using various survey samples, particularly household consumption and fishing effort surveys, it is possible to develop a rough indicator of **fishing pressure** at different sites and islands, in terms of number of active fishers per unit reef area (see earlier table). Proxies like this provide the beginnings of tools to tackle the problem of more rigorously assessing the impact of fishing on reef resources.

We will not present the analysis here, since the relevant data for several countries has not yet been processed, and a preliminary analysis may result in premature comparisons between the status of reef fisheries in different countries. However by comparing finfish size, biomass, reported catch, and numbers of fishers per unit area of reef at the sites surveyed, it looks as though it will be possible to classify sites into different groups for management purposes. Some sites have a relatively high

biomass on the reef, coupled with high catches, suggesting that fisheries are likely to be in better shape than sites which have a low biomass on the reef and high catches. A simplistic preliminary comparative analysis suggests that fishers in some Pacific islands where high catch-rates are reported from village surveys may be catching up to 20% of the available finfish biomass, whilst in other countries they may be taking as little as 0.3% of the available biomass per annum. These figures however have to be analysed in detail.

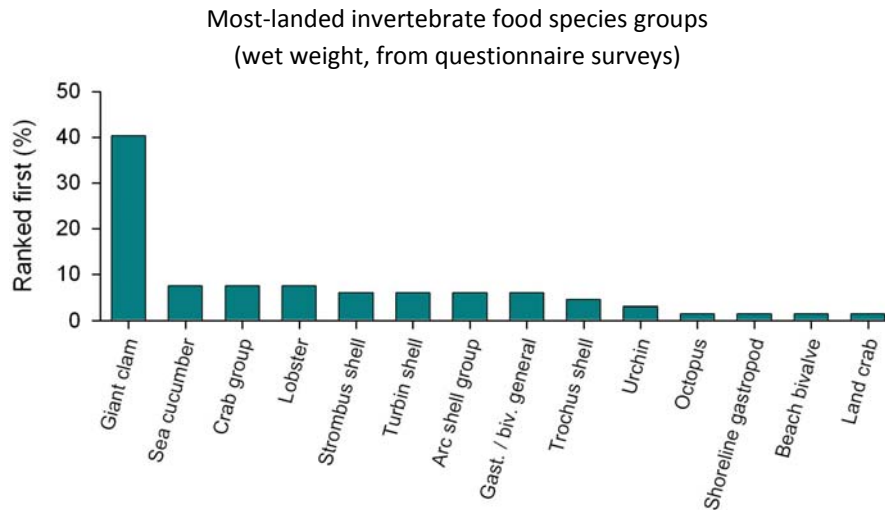
Without an indication of what constitutes a “healthy biomass”, and “normal” community and population structure at different sites and different seasons, it is difficult to say anything absolute about the status of the system as a whole. We must rely on proxies or indicators, and even this is not straightforward. In terms of the health of reef food fisheries and their supporting ecosystems, one indicator that has been suggested for general use in other parts of the world is the proportion of herbivorous fish to carnivorous fish. A high proportion of carnivores is said to be a general indicator of good reef ecosystem health, however that may not be as useful an indicator of reef ecosystem health in the Pacific Islands as it is in other parts of the world. Some Pacific Islands with notably low fishing pressure have notably high proportions of herbivores to carnivores, and some islands with apparently high fishing pressure have low proportions of herbivores. Whether this is due to environmental differences, or due to differences in targeting – some Pacific Island societies having more of a preference for herbivores than others – the derivation of reliable indicators of reef fishery and ecosystem health is obviously not going to be straightforward.



Another possible indicator of fishery “health” is the size-structure of the population. Fishing usually results in a reduction in the average size of individuals, and the quantitative information generated by the survey will also be analysed to see how useful size-ratio might be as an indicator, by comparing the size structure of the population of the same species in different places, and comparing this to other fishing pressure indicators. The results of this analysis will be explained in detail as part of the full Coastal Fisheries Status Report, to SPC’s governing council meeting in October 2008.

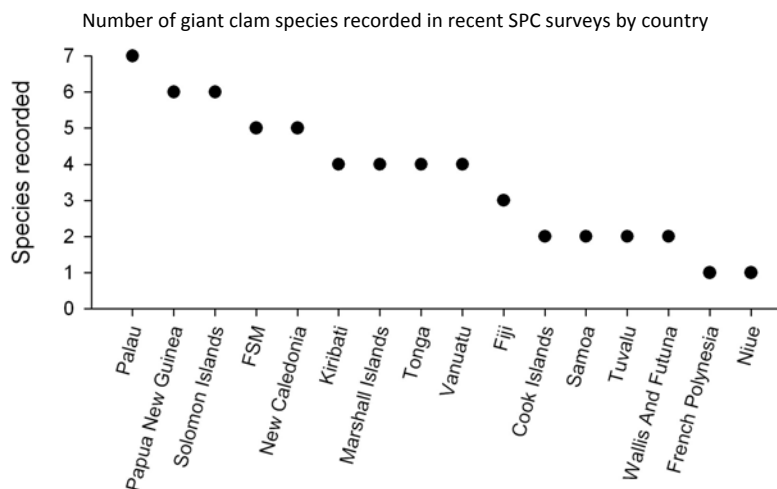
(c) Status of reef invertebrate food fisheries

Unlike descriptions for inshore finfish fisheries which are either related to habitat (lagoon, shoreline) or activity (net, line, spearfish), invertebrate fishing is generally less well defined. Similar to finfish, invertebrate fishing can be classified according to species (often actually species groups like “bêche-de-mer”) activity. And in the Pacific Islands invertebrates are collected for food through digging (infaunal fisheries in shell beds), gleaning (shoreline and shallow water), diving, or a combination of activities linked to in-water finfishing (usually spearfishing) activities.



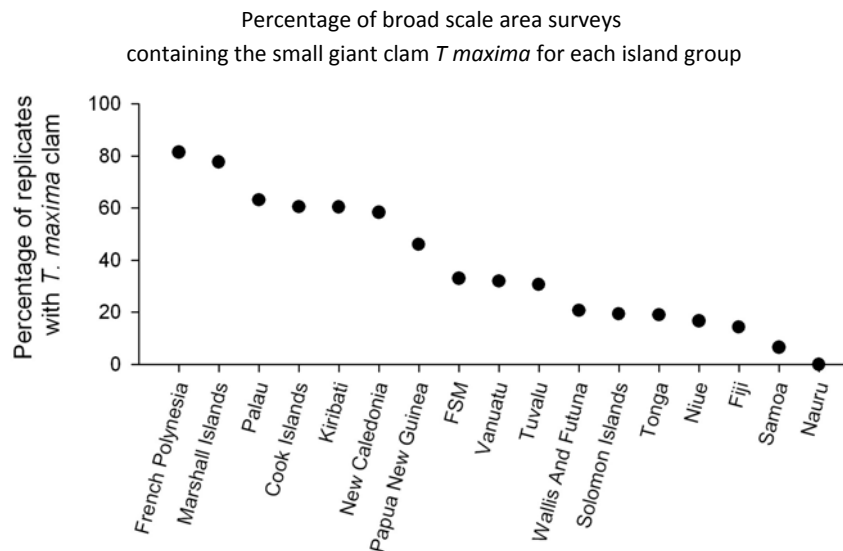
Gender differentiation is still apparent in many Pacific reef fisheries, but there appears to be a trend for increasing participation of men in the collection of invertebrates, and an extension in the range of fishing activities performed by woman (e.g. use of eye glasses for diving).

As in the case of fish, the number of species increases with environmental complexity of the area studied, and decreases in a cline from west to east across the Pacific. Taking an important invertebrate food species like giant clams as a single example of the data now available from the recent Pacific-wide reef fisheries survey, we can illustrate a variety of resource characteristics, such as the natural variation in the number of species in that group across the Pacific.



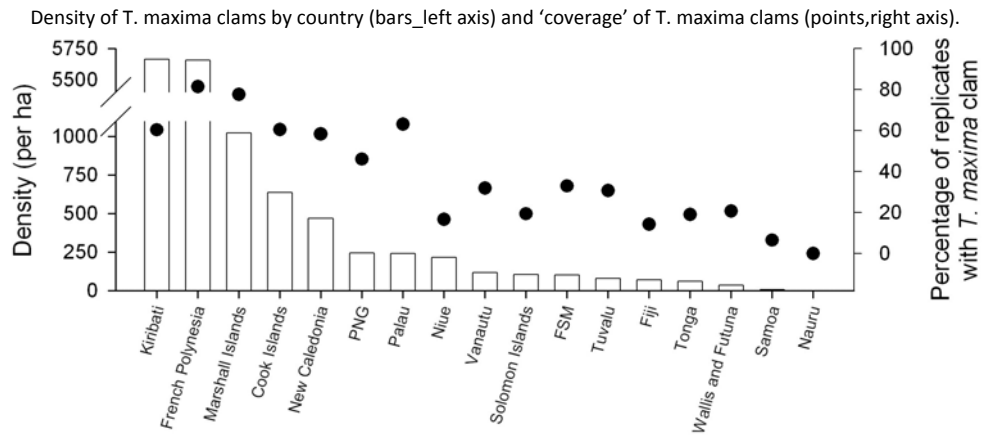
As with most resource groups the picture is mixed, with the smaller, commoner clam species found at most sites, while larger species like *Tridacna gigas* and *T. derasa* are rare. In the case of the largest giant clam, *T. gigas*, individuals were only recorded at 39% of survey sites within their geographical and ecological range, despite dead shells being commonly noted onshore at many more sites. In Kiribati, Solomon Islands and Marshall Islands, *T. gigas* was only present at one of the four sites surveyed in each country, with two of these countries being represented in the database by a single individual clam.

The present assessments are the first of their kind and there is no time-series of compatible data from the past to allow a review of changes over time. However the broad-scale assessments conducted as part of the whole suite of invertebrate surveys provide a surrogate measure of range and therefore “commonness” of a number of important species across the Pacific. For example, taking the elongate giant clam, *T. maxima* on shallow reef across countries, we get a simple presence / absence measure (coverage) that requires no density or size measurements. Changes in this measure over time will provide a rough estimate of broad scale changes in stock availability for the particular species of interest.

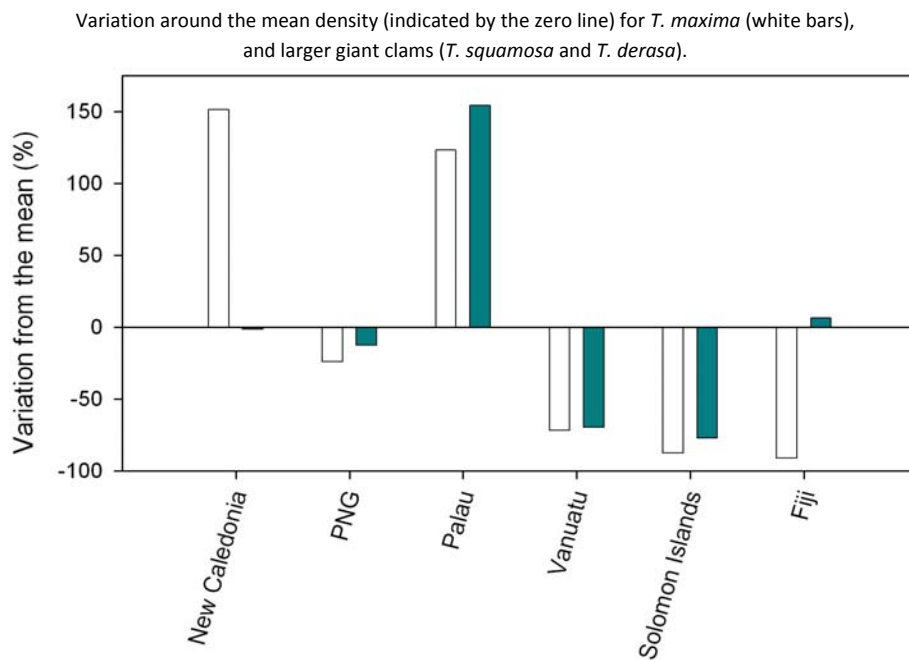


More targeted assessments provide a clearer picture of stocks in specific shallow reef locations. Biomass, a measure which incorporates both density and size information, is not always a useful measure for invertebrates, as unlike in fish, invertebrate target species are often partly made of shell, which complicates the comparison of weight measures between the large range of invertebrate body forms.

Unlike fish however, the density and size measurements of samples can be reliably measured and re-measured in known locations, as many important invertebrate stocks are sessile. If one examines the density of elongate giant clam, (*T. maxima*) across countries in the Pacific, it is noticeable that there is considerable variation across countries. Results from atoll lagoon systems in the eastern Pacific (where larvae of clams are entrained) will need to be compared with related systems, and considered differently to results from more ‘open’ lagoon systems that are characteristic of reef systems in Melanesia.



In the case of open lagoon systems in the western Pacific, results from New Caledonia, Papua New Guinea, Palau, Vanuatu, Solomon Islands and Fiji still show considerable variation around the mean for the density of *T. maxima* on shallow reefs (see below: white bars). Interestingly, *T. maxima* can in some cases be used as a surrogate for the density of larger clams (*T. squamosa* and *T. derasa*). One anomaly to this mirrored variation is seen in New Caledonia, where *T. maxima* are found at higher than average density, but larger species are surprisingly sparse. One possible explanation for such a result is that larger species of giant clam are still regularly marketed in the capital on the main island of New Caledonia.



Monitoring simple density measures in parts of a country and assessing related size measures for a few key invertebrate species will alert fisheries agencies to marked changes in availability of key invertebrate food resources, variations in natural recruitment and the condition of reefs. Simple measures taken from a manta board or in shallow water reef on snorkel can be conducted periodically by local fisheries officers to inform management agencies and local communities on the changing status of resources.

Setting thresholds around some key species groups, will allow management agencies to better inform communities, set triggers for management actions and more accurately set measurable goals for recovery plans. These thresholds can be calculated using relevant information already available from the Reef Fisheries Observatory Pacific dataset, and knowledge of the biological characteristics of individual species in question.

Status of invertebrate export fisheries:

Invertebrate export fisheries in the Pacific have a history dating back to before European settlement. These fisheries are primarily based on the sale of sea cucumbers (bêche-de-mer), trochus and pearl oysters (mother of pearl shell, ‘MOP’), but more recently, also the export of dead coral products and live molluscs, crustaceans and corals for the ornamental trade and aquarium industry.

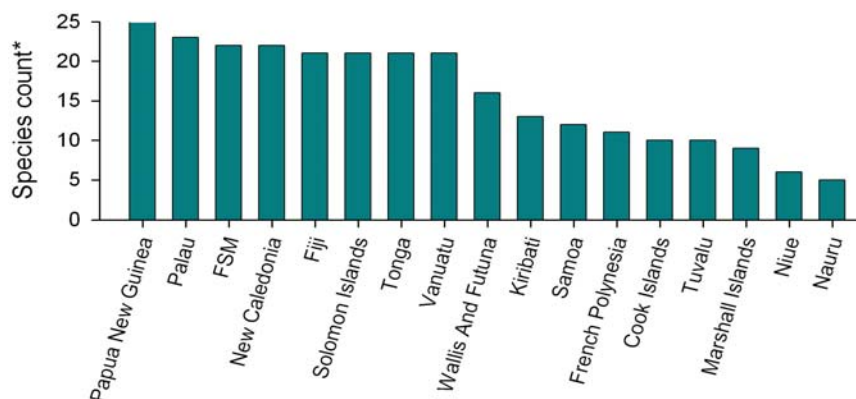
In the Western Pacific Region, most of these fisheries have exhibited boom-and-bust cycles throughout their history. Increased demand from Asian markets and elevated export prices since the 1980s has been the catalyst for increased and more sustained fishing, and at many localities, high-value species have been depleted and are now being replaced by previously unfished species of lower value.

Invertebrate export fisheries have the potential to provide income (derived from foreign currency) direct to remote village economies, where other opportunities to generate income can be difficult to find. Declines in the sustainability of sea cucumber and MOP fisheries are thus of widespread concern. As well as reducing foreign exchange earnings, damage to invertebrate export fisheries also contributes to outer-island depopulation and urban drift.

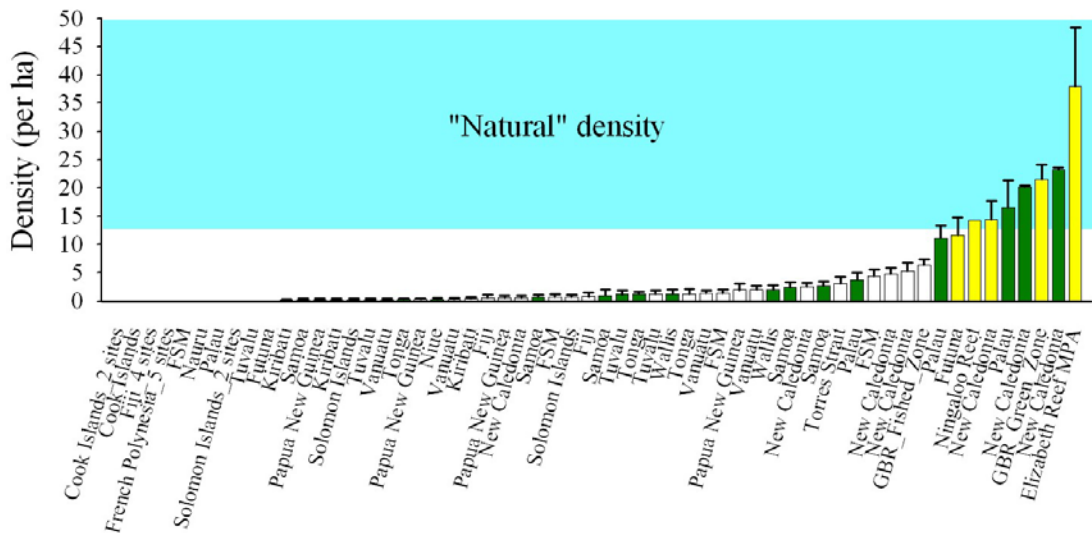
Here, we will concentrate on just two of these export invertebrate fishery groups, as examples of the kind of analysis and advice that is starting to emerge from the dedicated Pacific-wide surveys. These are however, two of the most “headache-inducing” fisheries that Pacific Island government fisheries services have to deal with. They involve, in many cases, significant overfishing, conflict between village fishers, exporters and investors, and marketing and quality certification issues.

Bêche-de-mer fishery (sea cucumbers)

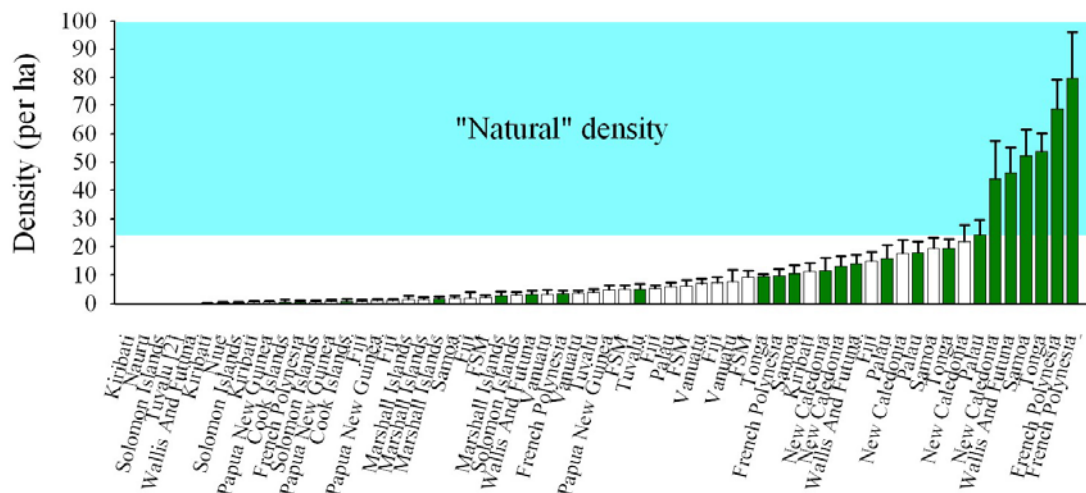
Currently, 35 sea cucumber species in the families Holothuriidae and Stichopodidae are thought to be harvested. Greater endemism occurs in Melanesian countries and natural species richness generally declines eastward from Papua New Guinea. On average, about 13 species are harvested per country.



Managers need a way to understand the current status of the fishery and implement management measures that maintain viable spawning densities in the fishery to ensure stocks can recover from fishing pressure. One approach would be to select and monitor ‘key indicators species’ within each group to gauge success of management measures and control the “on-off switch” for the fishery (the following indicator species might be used in certain areas: High value, low density species group: black teatfish, *Holothuria whitmaei*, Medium value, medium density group: leopardfish, *Bohadschia argus*), and Low value, high density group: lolifish, *Holothuria atra*)



Density of (above) the high-value/low-density species group indicator, black teatfish (*Holothuria whitmaei*), and (below) the mid-value/mid-density species indicator leopardfish (*Bohadschia argus*). Remote marine protected areas, and unfished sites are presented as yellow bars, while green bars represent areas where fishing has been halted for a decade or more.



As can be seen from density data presented, *H. whitmaei* can be found at >10 per ha-1 on unfished reefs, including, ‘closed’ (green zones) reefs on the Great Barrier Reef (Utiche, Welch and Benzie, 2004), isolated reefs near Lord Howe Island (Oxley et al., 2004) and Ningaloo Reefs, in Western Australia (Shiell, 2006). These results are from broad scale surveys but on rare occasions ‘point

densities' from the regional dataset can reach > 100 individuals per ha⁻¹ when studies are made of specific areas of habitat.

Noting the range of densities found at 'closed' sites it seems a conservative assumption that densities above 12.5 individuals per hectare represent a 'natural' density for this species on suitable habitat. When compared to reefs open to fishing, it becomes clear that most fished reefs have populations with less than about 5 individuals per hectare. Although some of this variation may be due to habitat differences, the fact that most of the 'open' reefs hold less than 25% of the 'natural' *H. whitmaei* populations suggests that these reefs are over-fished, and in some cases not recovering from overfishing, even with a decade or more respite from fishing pressures. This can also be seen for the data emerging for *Bohadschia argus*.

At current levels of production, as measured by wet weight, sea cucumbers fisheries in Fiji, Solomon Islands and New Caledonia are taking between 19–32% of the weight of tuna caught by national tuna fleets from their EEZ's. Therefore this fishery is not just a provider of income to rural coastal communities, but also represents a significant fraction of the total national resource production, which has implications for environmental change, as well as socioeconomic considerations.

Mother-of-pearl (MOP)

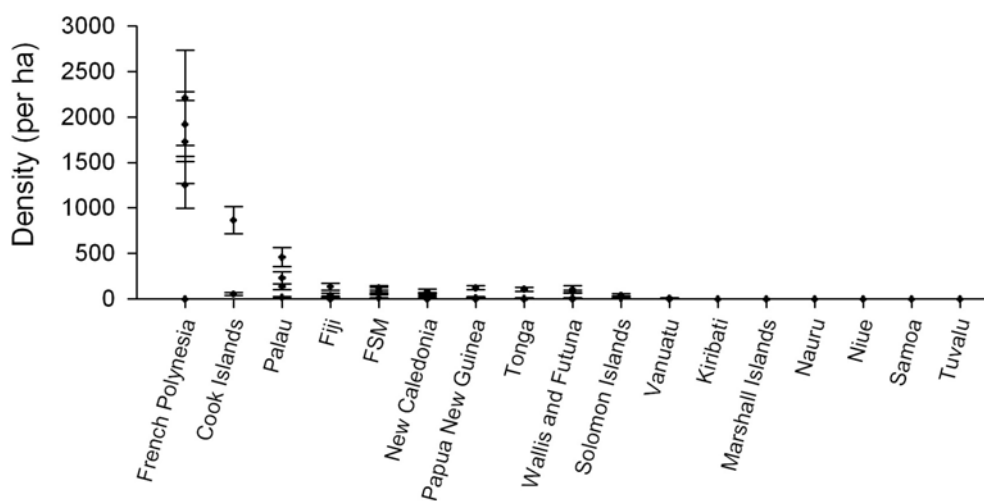
Pacific Island mother-of-pearl (MOP) fisheries are mainly trochus, but also cover pearl oysters and other nacre species. In the early 1900s records show large harvests of commercial topshell, *Trochus niloticus* being taken from virgin fisheries in the Pacific (catch-rates of 4,000 shells per person per day were known). Similar large harvests of pearl shell from atoll lagoons in the eastern Pacific have also been documented, although many pearl oyster beds never recovered and today most pearl shell reaching the markets is a by-product of spat collection technology and pearl farming.

Currently, commercial topshell, *Trochus niloticus* is still harvested commercially from most countries that have endemic or successfully introduced stocks. Data from the Reef Fisheries Observatory shows MOP stocks to be widespread; trochus and the blacklip pearl oyster (*Pinctada margaritifera*) were present at >72% of sites assessed in the recent comparative study, whereas greensnail, *Turbo marmoratus*, which was popular for decorative inlay work in east and south Asia, particularly Korea, was only recorded at 5% of sites. Over 65% of the sites assessed had received translocated trochus shell, in most cases by the historical introduction of adult shells, although hatchery releases have also occurred. Successful breeding stocks of trochus had been developed in most cases (65%) where translocations had occurred.

Past harvests from Fiji, Papua New Guinea and Solomon Islands, totalled over the past century, have produced more than 50,000 tonnes of trochus shell worth in excess of 200 million dollars at today's market prices, and much of this income was received directly by rural fishing communities. Today, harvests from the majority of active fisheries are depressed, with less than a handful of countries managing to sustain their trochus fisheries and maintain related income streams.

The Reef Fisheries Observatory instituted a suite of surveys to develop useful and relevant survey methodology, and assess the status of stocks to inform management agencies. Results show that in

general the majority of stocks assessed across the Pacific were at very low densities, and experiencing limited recruitment.



Density (\pm SE) of trochus at shallow water reef stations surveyed on snorkel.

In this work only 8 sites had stocks at good commercial densities (500+ per ha), and all of these higher-density sites practised a “limited open season” form of management to control fishing pressure. But at most sites harvesting was permitted year-round (mean of 33 trips per year), with fishers taking many small catches of trochus and slowly depleting stocks to levels where spawning success was compromised (mean of 17 trochus harvested per trip).

A second survey using a SCUBA based approach yielded a similar result, with most sites holding low densities. Nine of these ten sites that held the greatest density of trochus had implemented a limited opening season to control fishing pressure, and continued to make periodic commercial harvests.

Interestingly, despite the large number of depleted sites, 44% of all sites held commercial threshold densities in at least one of the in-site survey stations assessed (site average is determined from a multiple number of stations). This means that in many sites, small pockets of shell were present in aggregations at high enough density to provide a source for successful reproduction and stock recovery if management controls could be implemented. Trochus need to be in close proximity for reproduction (to induce broadcast spawning and ensure successful fertilisation of gametes) and this will not occur effectively when they are fished to low densities.

To allow stocks and therefore fishery productivity to rebuild, closures of underperforming (and declining) fisheries needs to be implemented, and in some cases shell needs to be aggregated to kick-start a return to productivity. Regional cooperation to coordinate harvests by participating countries, in order to supply a continuous stream of product to market could be of great benefit to all. It would provide overall industry security, by providing confidence to those investing in machinery, while decreasing price fluctuations driven by inconsistent supply.

In order to develop a model to describe productivity from well-managed fisheries, the Reef Fisheries Observatory examined past harvests from trochus fisheries in Palau, Cook Islands and Wallis. By surveying the fishery, and examining recordings from past harvests, preliminary calculations suggest that fishers should target 3-4 year rotations in fishing, and harvest the equivalent of 180 shell per ha yr-1 from the core trochus fishery area.

Status of reef export finfisheries:

Live reef food fish trade⁷

The trade in live reef fish to restaurants in Hong Kong and southern China is a relatively new phenomenon and has attracted particular management concern because the fishery targets a group of species that is relatively fragile, in fishery management terms. The most sought-after fish are found in two families, as follows: Serranids: *Plectropomus areolatus*, *Plectropomus leopardus*, *Cromileptes altivelis*, *Epinephelus fuscoguttatus*, *Epinephelus polyphekadion*, *Epinephelus lanceolatus*, *Epinephelus coioides*, Labridae: *Cheilinus undulatus*

The trade from the Pacific Islands, at its height, supplied around 10% of this market, and nowadays is much reduced from its heyday in the late 1990s.

Country	1997	1998	1999	2000	2001	02 - June	Total (mt)
Taiwan	2,607	1,721	1,081	1,019	474	69	6,970
US Oceania	6	3	0	0	12	19	40
Kiribati	0	8	15	0	0	0	23
Palau	0	1	0	0	0	0	1
Nauru	0	0	0	0	0	0	0
Australia	460	476	429	751	1,151	609	3,877
Solomon Isl.	37	7	0	0	0	48	93
Fiji	0	0	0	14	9	0	23
New Zealand	0	0	0	0	2	0	2
PNG	15	0	5	0	0	0	20
Total (kg)	3,125	2,216	1,531	1,785	1,648	745	11,049

Live reef fish exports from the Pacific to Hong Kong (tonnes weight)

The latest information that SPC has on these fisheries is that only three Pacific Island countries were exporting live reef fish in 2006, as follows:

- Papua New Guinea: Three operators with one in the process of suspension due to cyanide use. Target species are coral trout and grouper, with the 2005 exports estimate at 300 tonnes to Hong Kong. A management plan and monitoring is being implemented, including species quotas and allocated fishing areas.
- Fiji: One operator targeting coral trout. Exports for 2005 were two tonnes by air to a US market, while in 2006 there were fortnightly shipments of up to 200 kg. A management plan and monitoring is being implemented, including species quota, allocated fishing area, and air freighting only.
- Kiribati: One operator; operation stopped at the end of 2004, re-opened at the end of 2005, and closed in 2006 due to ciguatera, with groupers being the main species group targeted. Exports in 2004 were 70 tonnes in three shipments to Honk Kong. Management plan and monitoring arrangements are still in a draft form.

⁷ Parts of this section are abridged from an SPC LRFT Bulletin article http://www.spc.int/coastfish/news/LRF/17/LRF17_43_Yeeting.pdf

The decrease in the number of active exporting countries has been caused by the improved awareness of the public and fisheries departments on the implications and consequences of the trade especially in trying to meet the minimum shipment tonnage. For sea-transported fish, exporting companies are now requesting 20–30 tonnes of fish per shipment (compared to 10–15 tonnes 10 years ago). In this respect, several companies in the Pacific are considering air freighting which is highly recommended over sea freighting as smaller amounts of fish are required (500 kg of fish per fish bin), with the fortunate side-effect of putting less pressure on resources.

Hong Kong remains the main market but the mainland China market is expanding quickly. There is a small market in the West Coast of the US, and the US market provides a good market option for most Pacific countries instead of competing with Asian suppliers (Indonesia and Philippines) into the traditional Hong Kong market.

The species composition of exports from the Pacific has remained the same but with a slightly increased acceptance of low value species by the operators/exporters. The hump head wrasse is still in great demand in the markets, but supply is likely to be increasingly limited in the near future with the recent red listing of the species under CITES II and with Hong Kong's strong intentions to enforce its CITES obligation.

The mariculture of groupers has had success with full cycle commercial rearing of two important species, *Cromileptis alitvelis* and *Epinephelus polyphekadion* for a number of years now. It was expected therefore that these two species will flood the market causing significant drops in the prices of even wild caught supplies. This has not happened as expected, with still quite a high demand of these targeted species from the wild.

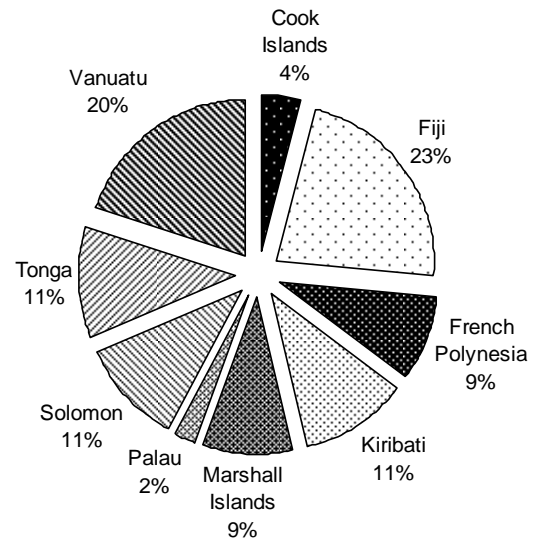
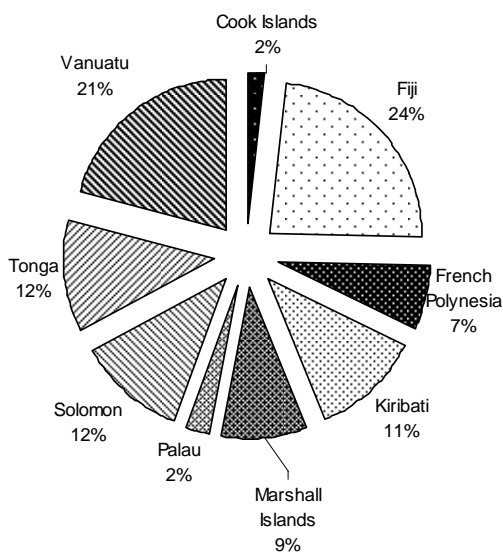
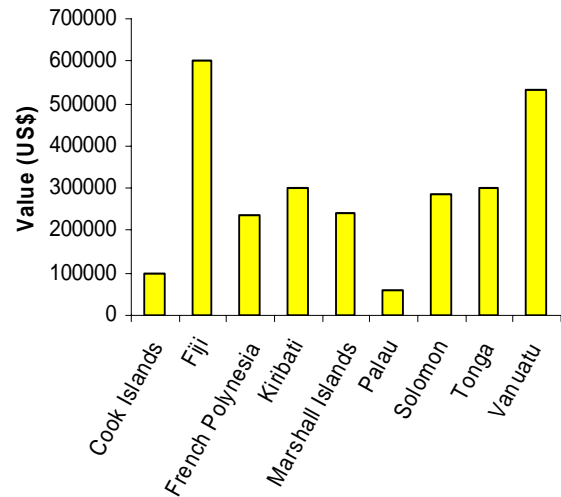
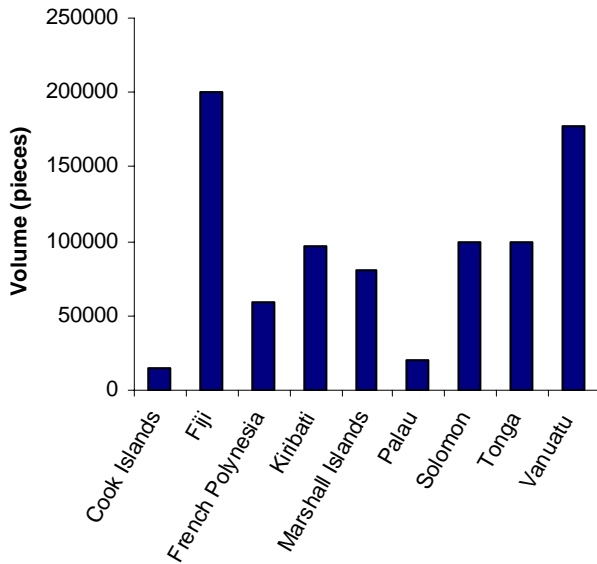
Live reef ornamental fish and aquarium trade

The export of aquarium fish and invertebrates from the Pacific has occurred for over 20 years but it has only recently begun to intensify. The main export markets are the USA, Europe and Japan. Markets such as China and other countries of south East Asia have recently come into the scene. There is a great diversity of products that are being traded such as coral reef fish, hard corals, soft corals, giant clams, live rocks, invertebrates.

For aquarium fish only, there are around 800 000 fish exported each year worth around USD\$2.7 million dollars at export prices. Over 10 countries in the region are involved in this trade. They export fish using a wide range of collection and handling practices, ranging from low technology ocean holding in Kiritimati Island (Kiribati) to high technology land-based facilities of Fiji. All together, there are about 30 private companies collecting aquarium fish in the region targeting a wide range of species, from the low value damsel fish to the rare angelfish of some areas of the Pacific. The competition with southeast Asia (Philippines, Indonesia, Sri Lanka) is very strong. To be cost-effective, a lot of ornamental fish companies employ professional divers from overseas who have long experience of fish collection and handling.

At the moment, the SPC is in the process of developing a database that will keep the live aquarium trade fisheries information updated on a yearly country-by-country basis. This will help governments to regulate and sustainably develop this fishery.

According to data collected for nine countries in the Pacific, Fiji, Vanuatu, Solomon Islands, Kiribati and Tonga are the major exporters. The Cook Islands export the smallest volume of fish on average but gets the highest average export price for its products.



Average yearly volume (pcs) of ornamental fish exported from Pacific countries. (source: fisheries department, UNEP)

Average yearly value (USD\$) of ornamental fish exported from Pacific countries. (source: fisheries department, UNEP)

Other organisms contributed significantly to the export data. In 2004, Fiji, Tonga and Solomon islands exported nearly 300,000 pieces of live coral through the aquarium trade (SPREP and Tonga Fisheries data). Some countries such as Vanuatu or Kiribati have prohibited the trade of wild corals but encourage the practice of farming corals, using fragmentation techniques. It is hoped that in the future, farmed corals will replace most wild caught colonies, although not all species of coral can be farmed.

Live rock is in very high demand in the global trade for biofiltration of seawater aquaria. Live rock collection is often seen as a destructive activity and some private companies have taken the initiative of farming live rock. Major countries exporting live rocks are Fiji, Tonga, Vanuatu and Marshall islands. In 2004, 1,500 tonnes of rocks were harvested from the reefs of Fiji (SPREP data). The live rock fishery can be managed by implementing clear guidelines on harvesting areas and practices and limiting the overall amount that each area can export.

The giant clam is the example of an aquarium commodity that is now nearly all sourced from aquaculture. The biggest exporter of wild clams in recent years used to be Vanuatu with 17,000 pieces of *Tridacna crocea* (CITES data) exported in 2000. However Vanuatu has now banned the wild trade and encouraged the development of small-scale giant clam farms. Nowadays, the Pacific exports around 60-80,000 small aquacultured clams per year.

Other invertebrate species such as molluscs, echinoderms, crustaceans are also collected and exported by aquarium traders from the Pacific. Most of them generally fetch moderate value and only account for a small percentage of the global trade. Management guidelines for this small but diverse fishery will be developed in the near future.

Eco-labelling of Pacific Island aquarium fishery products have been attempted by the Marine Aquarium Council (MAC) through documentation of standards applied along the production chain, from the ocean to the retailer. The standards were to achieve the following goals: (i) the creation of sustainable fishery practices, (ii) the creation of good fishing and handling practices prior to export and (iii) the creation of good handling and transport practice during export and import. Unfortunately, MAC certified products accounted for less than 1% of total traded products globally, and the certification process has been abandoned recently.

In the Pacific region the aquarium trade provides income for more than 800 households and accounts for more than US\$15 million dollars worth of foreign exchange annually. Indeed this is a significant source of employment and income for Pacific people, but in order to be sustainable, the fishery has to be managed fairly tightly. Fisheries department have endeavoured to regulate these fisheries in recent years, such as closed areas, limiting licenses, gear restriction but a lot of work is yet to be done to fully insure the future of the aquarium resources.

Nearshore fisheries

By “nearshore fisheries” we mean fisheries for organisms in the water-column or on the ocean floor outside lagoons and surface-breaking reefs, within territorial waters and the EEZ. These are usually pelagic finfisheries (fishing from 0–500 m depth) and tuna is the major component of the catch, but we also include deep-bottom, deep-slope and offshore seamount fisheries (such as deepwater snapper, deepwater crabs and shrimp) in this category (bottom fishing from 100–1000 m depth). These fisheries are usually fully commercial and carried out by Pacific island companies, professional fishers, or tourist gamefishing operations, but artisanal and subsistence nearshore fisheries are also present, particularly around atolls.

A major component of the nearshore fishery catch is tuna, and these highly-migratory tuna stocks are also fished by comparatively well-observed and reported industrial fleets, so we have a

comparatively good knowledge of the status of the regional tuna stocks that nearshore fisheries rely upon. We also know something about the status other pelagic species that are caught by both small-scale and large-scale tuna vessels, such as marlin, shark and leatherback turtle, however, we know very little about just how much tuna and other nearshore pelagic fish is caught by non-commercial Pacific Island fishers, and in many countries deepwater snapper landings and effort are not consistently recorded.

Status of nearshore tuna

The status of the four main tuna stocks in the western and central Pacific Ocean (WCPO), yellowfin tuna (*Thunnus albacares*), bigeye tuna (*Thunnus obesus*), albacore tuna (*Thunnus alalunga*), and skipjack tuna (*Katsuwonus pelamis*), are regularly assessed by the SPC's Oceanic Fisheries Programme, and the reports can be found at (<http://www.spc.int/oceanfish/Html/SAM/StockAss.htm>). In addition the Forum Fisheries Agency (FFA) produces reports on the status of economy and industrial tuna fisheries, and these can be found at (<http://www.ffa.int/node/862>). All of this information also informs the wider deliberations of the new Western and Central Pacific Fisheries Commission (WCPFC), which is the regional fisheries management organisation for the tuna and other highly migratory fish stocks of the Western and Central Pacific Ocean.

Tuna are highly migratory species, which are found throughout the EEZs of PICTs. The industrial purse seine fishery, and to a certain extent the longline fishery (larger vessels from distant water fishing nations – DWFN), fall outside the scope of this status of coastal fisheries report. However, there is an overlap of tuna fishing activities, with domestic longline vessels and small-scale tuna boats fishing in association with fish aggregating devices (FADs), trolling close to the reef, and trolling tuna schools usually within 10 nm of the reef. Trolling and mid-water handlining from small-scale vessels is covered in more detail in the next section, as a mix of other nearshore pelagics are also taken in the catch.

Looking at the longline catch by vessel type, the catch by domestic Pacific island vessels is consistent at around 36,000 mt/year from 2001 to 2006. The number of domestic vessels, however, has declined from 490 in 2001 to 412 in 2006, mainly due to the reduction of the small-scale alia fleet in Samoa, with the overall Samoan fleet dropping from 149 vessels in 2001 to 54 vessels in 2006.

Longline catch from within the EEZs of PICTs over the period 2001 to 2006 (source: SPC, OFP database).

Year	Longline catch in metric tonnes from the EEZs of PICTs		
	DWFN fleets	Locally-based foreign	Domestic
2001	31,412	6,675	32,792
2002	28,771	5,077	36,992
2003	20,039	12,833	33,345
2004	36,311	12,890	37,354
2005	25,556	12,643	31,280
2006	29,758	12,321	36,829

Fish Aggregating Devices (FADs) are an important component of small-scale tuna fishing operations, and just about all SPC island members have used them at some stage over the last 25 years with varying degrees of success, usually in regard to their lifespan. The industrial tuna fishing companies in Papua New Guinea and the Solomons have ongoing FAD programmes for their fleets, and they allow small-scale fishers to use them as well. To further utilise the FADs in Papua New Guinea, pump-boats have been brought in from the Philippines, and they jig for tunas around the FADs at night, usually with good success.

The importance of FADs for increasing tuna catches for small-scale fishing operations is also highlighted in the table below. When looking at the trolling catches of tunas taken from FADs it is around three times the catch of tunas taken when trolling in open water chasing tuna schools and trolling around the reef.

There is also one significant small-scale tuna fishery in the Pacific that does not use FADs; the troll and pole fishery from South Tarawa in Kiribati, where around 200 outboard-powered skiffs fish on a daily basis (weather permitting) for tunas. This fishery catches over 1500 mt annually, with the catch all sold locally.

Status of other nearshore pelagic fish

The nearshore fishery for non-tuna pelagics, is primarily a surface troll fishery outside the reef and around fish aggregating devices (FADs), where the target species are wahoo (*Acanthocybium solandri*), mahi mahi (*Coryphaena hippurus*), marlins (*Makaira* spp. and *Tetrapturus* spp.), sailfish (*Istiophorus platypterus*), barracudas (*Sphyrna* spp.) and rainbow runner (*Elagatis bipinnulata*). In those PICTs where Spanish mackerel (*Scomberomorus commerson*) are available, towards the west of the region, these are also targeted.

Catch of tuna (skipjack and yellowfin) and non-tuna species (primarily wahoo, mahi mahi and marlin) recorded for Niue and Rarotonga, Cook Islands over the period 2002 to 2004 (from logbook data that covered around 30% of the fleet).

Fishing method	Niue Catch in kg		Rarotonga catch in kg	
	Tuna species	Non-tuna species	Tuna species	Non-tuna species
Trolling FADs	15,057	9,438	30,239	3,882
Open-water trolling	4,572	21,152	6,507	9,102
Mid-water FAD fishing	2,124	849	3,859	1,208
Total	21,753	31,439	40,605	14,192

Trolling is carried out in all PICTs, with thousands of small-scale outboard-powered dinghies and skiffs, as well as some motorised outrigger canoes involved. Some of these vessels also use mid-water fishing techniques, such as vertical longlines, drop-stone and palu-ahi (mid-water handlining), both around FADs and in tuna holes. Paddling and sailing outrigger canoes are also commonly used for mid-water handlining, both around inshore FADs and in 'tuna holes' close to the reef. The Cook Islands and French Polynesia each have over 300 such vessels/canoes fishing for both subsistence needs and livelihoods. Catches vary considerably from country to country, although data is scarce as in most PICTs, there is no data collection system. The table above highlights the importance of non-

tuna catches in two PICTs, Niue and Rarotonga, Cook Islands. For Niue, the non-tuna catch recorded was 50% more than the tuna catch, while in Rarotonga, the non-tuna catch was around one-third the tuna catch.

Nearshore pelagics and the use of FADs are also important for the slowly expanding gamefishing and sportfishing operations in the Pacific. Most PICTs now have a couple of charter fishing operations taking paying passengers to fish for marlin, wahoo, mahi mahi and tunas. There are also an increasing number of recreational fishers chasing these species, and again, there is no data collection from these fishers, so there is no real idea of what catches are being taken and the overall effect on these stocks.

Very little is known about the stocks of non-tuna pelagics as listed above, although through the work of the new WCPFC, some of these species, such as some marlin species and possibly wahoo, will be targeted for stock assessment work in the future. There are also no management plans in place for these species.

There are a range of other fishing activities targeting pelagic species in PICTs, some are traditional, while others are using new technologies, and these include:

- Scoop-netting of flyingfish at night with light attraction is widely practiced in Polynesian countries and territories with many small-scale vessels involved. In the Cook Islands and French Polynesia, boats have been specifically designed with forward mounted steering to allow the chasing of flyingfish, and battery-powered spotlights are mounted on bike helmets to make the spotting easier. Little is known on the number of flyingfish species being targeted, and the status of these stocks.
- Baitfishing in lagoons and in passageways at night using light attraction and a Bukiami net targeting sardines, pilchards and anchovies, plus many other species, is a method practiced by commercial tuna pole-and-line vessels. The number of countries using this method has dwindled over the last 25 years, with this only conducted in Fiji, Palau and the Solomon Islands at present. However, from 2007 to 2009, SPC will be conducting a regional tuna tagging project, using a chartered pole-and-line vessel from the Solomon Islands, and baitfishing will be conducted in the countries where the tagging takes place.
- There is a growing interest in fishing for squid in the region, and the main technique used is a night fishing method using light attraction and squid jigging machines. Some trials have taken place in the past in different PICTs, and Palau had one vessel fishing for large diamond-backed squid in the late 1990s. Little is known about the potential for squid fishing in the region or about the status of squid stocks.

Status of deepwater snapper and other demersal nearshore fisheries

The deepwater snapper fishery is based on fishing between 100 and 400 m depths, on the outer reef slope and on seamounts. The main families being targeted are the deepwater Lutjanids (Etelis, Aphareus, Paracaesio, and Pristipomoides), shallower water Lutjanids (Aprion and Lutjanus), Lethrinids (Gymnocranius, Lethrinus and Wattsia), and Serranids (Cephalopholis, Epinephelus, Saloptia and Variola). A range of other species are also taken, including Gemplids (Ruvettus and Promethichthys) and other miscellaneous bony fishes.

Deepwater snapper fishing activities were promoted in the late 1970s and 1980s, with SPC conducting 50 in-country projects in 19 of its PICT members during this period. These activities were conducted to test the viability of catching deepwater snapper species using simple low-cost handreels, understand the species composition, and introduce local fishers to the fishing gear and train them in the fishing methodology. A regional assessment was undertaken in 1992 on the data that had been collected, resulting in estimates of virgin biomass for each PICT, plus an estimated MSY per PICT, which was based on 10–30% of the virgin biomass being harvested annually. As the length of the 100 fathom (180 m) isobath was used in the calculation, naturally PICTs with limited area had a very small virgin biomass (Nauru, 3 t; Pitcairn, 11 t; Guam, 22 t), while those with a large area had a much larger virgin biomass (Papua New Guinea, 4881 t; Fiji, 4092 t; French Polynesia, 3427 t).

**Roughly-estimated sustainable yield
per annum for deepwater snapper fisheries**

Country/Territory	Yield range (tonnes/yr)
American Samoa	17-50
Palau	16-49
Cook Islands	41-124
Federated States of Micronesia	145-435
Fiji	409-1,230
French Polynesia	343-1,028
Guam	9
Kiribati	73-219
Marshall Islands	111-332
Nauru	0.25-0.75
New Caledonia	109-327
Niue	7-21
Northern Marianas	99
Papua New Guinea	488-1,464
Pitcairn	1.1-1.3
Solomon Islands	171-513
Tokelau	10-30
Tonga	113-338
Tuvalu	22-67
Vanuatu	98-294
Wallis & Futuna	10-30
Samoa	19-57
Total	2,313-6,719

Source: Dalzell & Preston, 1992

The deepwater snapper stocks are fragile, and only those PICTs with a large fishing area have the stocks needed for developing a fishery. Even in these locations, the chance of localised stock depletion is high unless fishing effort is spread over a large portion of the available fishing area.

Development of the deepwater snapper fishery in PICTs has been sporadic, with fishing for these species being done on an *ad hoc* basis from small-scale vessels working close to their home port. Targeting of these species occurs in Guam (up to 20 small-scale vessels when weather permits), New

Caledonia (8–10 full-time vessels), Northern Mariana Islands (5 vessels over 15 m), Tonga (24 vessels full-time) and Vanuatu (over 100 small-scale vessels). In Papua New Guinea and the Solomons, the targeting of deepwater snappers has been promoted through specific development projects, however, it has not caught on. In Samoa, deepwater snappers were targeted in the late 1980s/early 1990s with fishers reporting a decline in stocks from 1992 to 1994, when fishing effort turned to the tuna fishery. With declines in the tuna fishery in the early 2000s, some fishing effort has switched back to the deepwater snappers. Tonga has the most consistent deepwater snapper fishery that started in the 1980s and continues today. However, the fishery, which is based on fishing the many seamounts within the Tonga EEZ, is reporting a decrease in the size of fish and volume of catch, which indicates the stock is being overfished, at least in some locations.

Very few PICTs have management plans in place for the deepwater snapper fishery. The three US territories (Guam, CNMI and American Samoa), have had management plans in place since August 1986, and these are reviewed regularly. In 1987, Fiji put management guidelines in place for this fishery, although they have not been updated or revised since then. A management plan was drafted in 1995 for the Tuvalu deepwater snapper fishery, although minimal fishing has been recorded. Tonga has had a series of draft management plans for their deepwater snapper fishery, the most recent being done in 2007. There has also been some concern expressed in New Caledonia about the state of their deepwater snapper fishery, with the fisheries department embarking on the development of management arrangements in 2008.

Other deepwater bottom fishing activities

Over the last 25 to 30 years, a range of other fishing activities have been trialled for deepwater species, and these include:

- Deepwater shrimp fishing trials were conducted in many PICTs in the 1980s, with catches in the most part too low to be economically viable, plus these stocks were assessed as being very fragile.
- Deepwater trawling trials have been conducted in the search for alfonsino and other commercial species in Fiji, New Caledonia, and Tonga. Although some commercial species were taken during the trials, they were not in commercial quantities to warrant further fishing. No real data is available on these trials, the catches taken, and little is known on the stock status of these species.
- The trapping of deepwater crabs in depths of 500–700 m has occurred in Vanuatu, Palau, Tonga and the Cook Islands. Little is known about the fishery or the status of deep-water crab stocks.

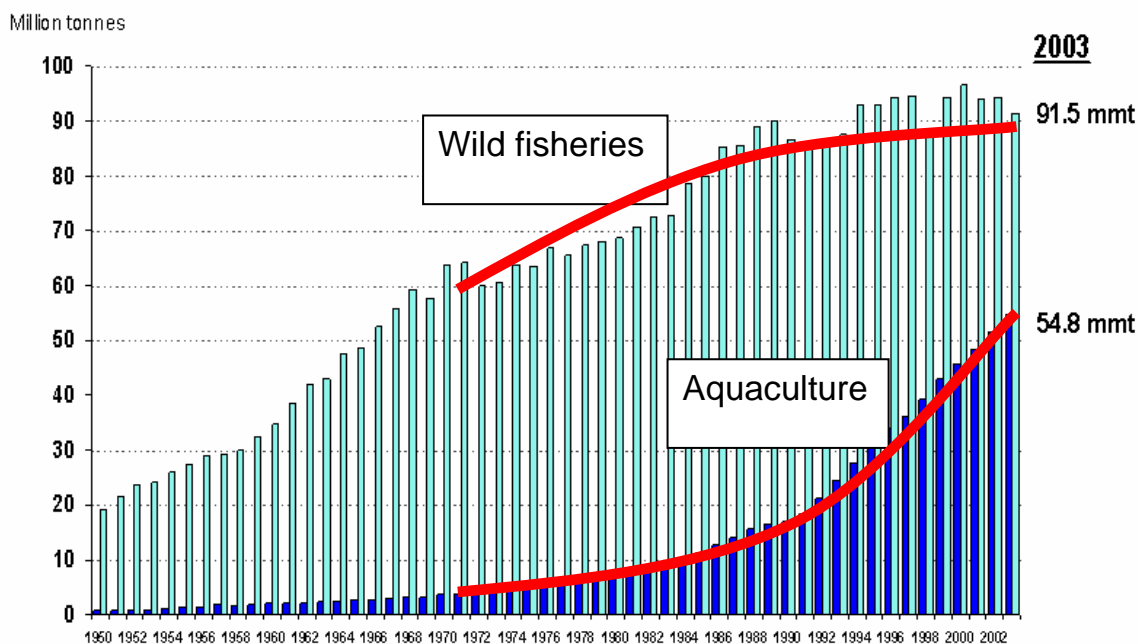
Aquaculture

In “aquaculture” we include marine aquaculture (mariculture), freshwater (usually pond) aquaculture, and freshwater fisheries.

Global aquaculture

Aquaculture is amongst the fastest growing food sector globally, accounting for almost 50% of the world’s food fish. According to the United Nations Food and Agriculture organisation (FAO), in 2004 the production was 60 million tonnes worth USD\$70 billion dollars compared to less than one million

tonnes in the early 1950s. This growth has been most rapid in the past few decades as advances in/and the convergence of sciences such as fisheries ecology, nutrition, genetics, agronomy and agriculture engineering has made aquaculture a feasible and sustainable option.



World production of fisheries and aquaculture (FAO)

FAO estimates that meeting the demand of fish consumption per capita from the world’s growing population will require an additional 40 million tonnes per annum by the year 2030. With the sustainable level of harvest amongst the worlds major fisheries reaching a plateau, aquaculture is being increasingly sought to make up this shortfall. The Worldfish Centre estimates that by the year 2020, aquaculture could account for 70 percent of the worlds fish supply.

Aquaculture in the Pacific

The growth of aquaculture in the Pacific has followed the world’s global trends. The modern aquaculture introduced to the region in early 1950s by SPC has only become established within the past few decades. Today it is a uniquely tailored sector which is becoming increasing more widespread. One feature of aquaculture in the Pacific is that it is quite diverse for such a relatively small region.

Like many primary development sectors in the Pacific, aquaculture is often constrained by the remoteness of the region and distance to markets, lack of basic infrastructure, institutional capacity, social/cultural values and marketing. Models which are technically feasible in one place cannot simply be transposed into another and many Pacific Island countries have spent years of trial and error in applied development and research. The early period of development was fraught with failures, notably the attempt to introduce Mozambique tilapia as a food fish in the Pacific in the 1950s-60s, by the SPC.

The sector is supported by government aquaculture facilities which are often housed institutionally within fisheries departments. Almost all Pacific Island countries have significant aquaculture facilities. These include the: Palau Mariculture Demonstration Centre; Kosrae National Aquaculture

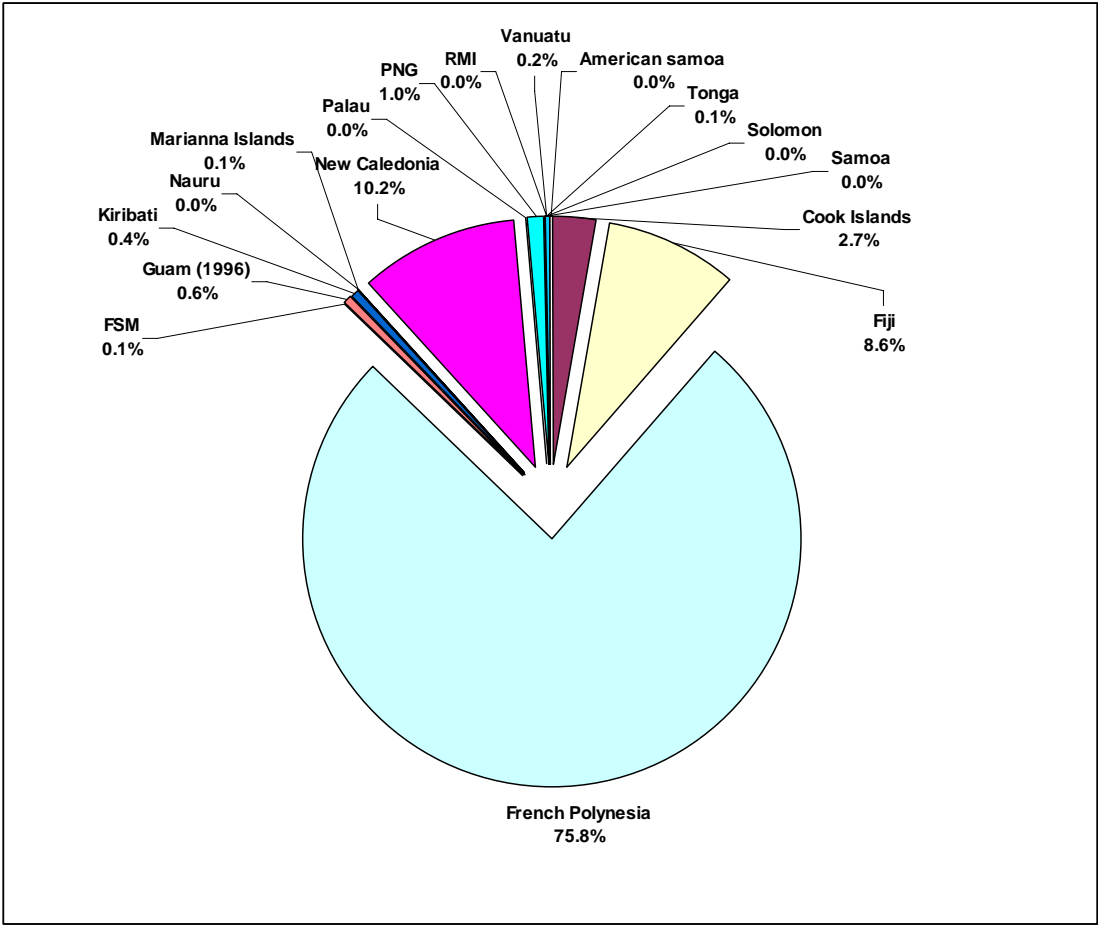
Centre, Micronesia; Kiribati black pearl oyster hatchery; IFREMER/SPE Vairo facility, Tahiti; Tongareva Marine Research Centre, Cook Islands; Sopa mariculture facility, Tonga; Nadurololou Aquaculture Research Station, Fiji; St Vincent Station IFREMER, New Caledonia; Nuse Tupe Station WFC, Solomon Islands; and Aiyura Highland Aquaculture Development Centre, Papua New Guinea.

Annual value and volume of aquaculture production in the Pacific

At present the average value of aquaculture production is estimated at USD216 million dollars (between USD160-265 million dollars) and a volume of 4,600 tonnes and 260,000 pieces depending on the commodity being quantified. Aquaculture may contribute some form of full time or partial employment for around 25,000 persons in the region.

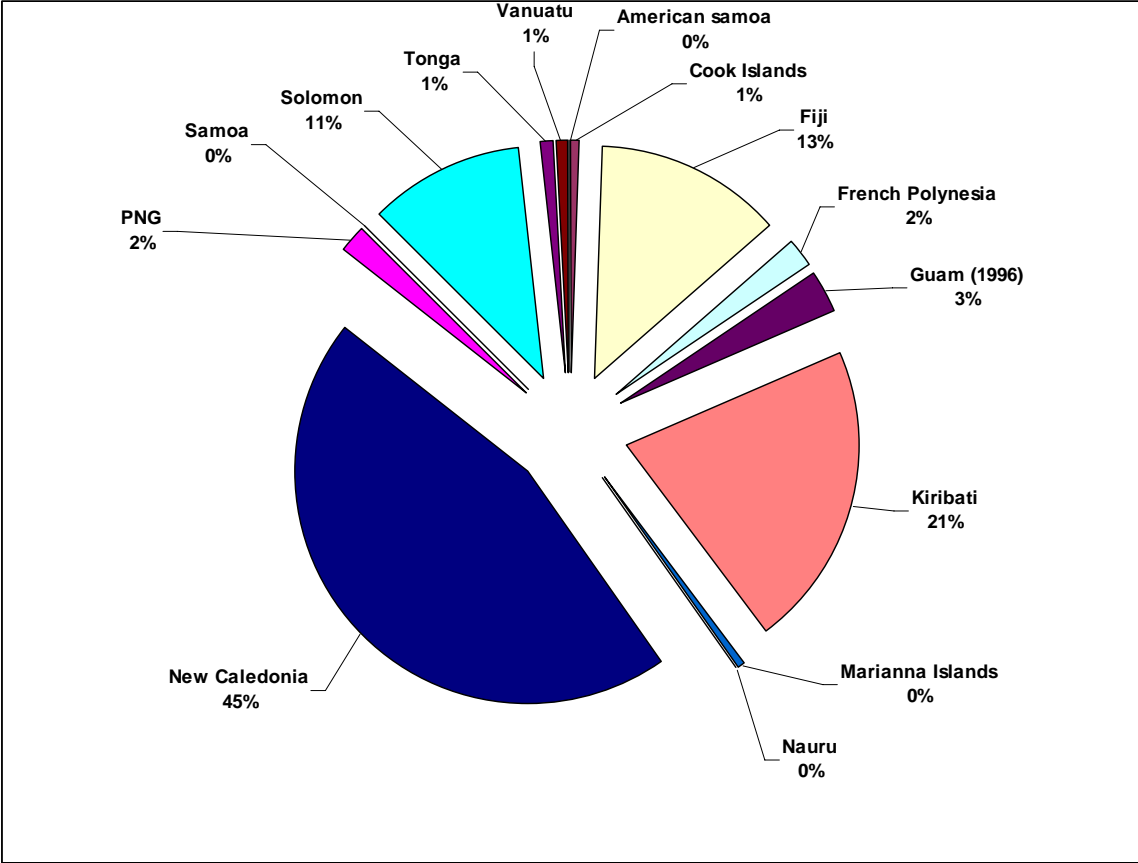
Amongst the Pacific Islands most of the monetary wealth is generated by just a few countries. The dominant country amongst these is French Polynesia which accounts for almost 76 percent of the total value. New Caledonia, Fiji Islands and the Cook Islands make up almost all of the remaining total value of production. The key commodities produced by these countries are cultured pearls and marine shrimp, which are high value and low volume commodities suitable for intensive culture systems and exports to lucrative markets overseas.

Annual value of aquaculture production in the Pacific.



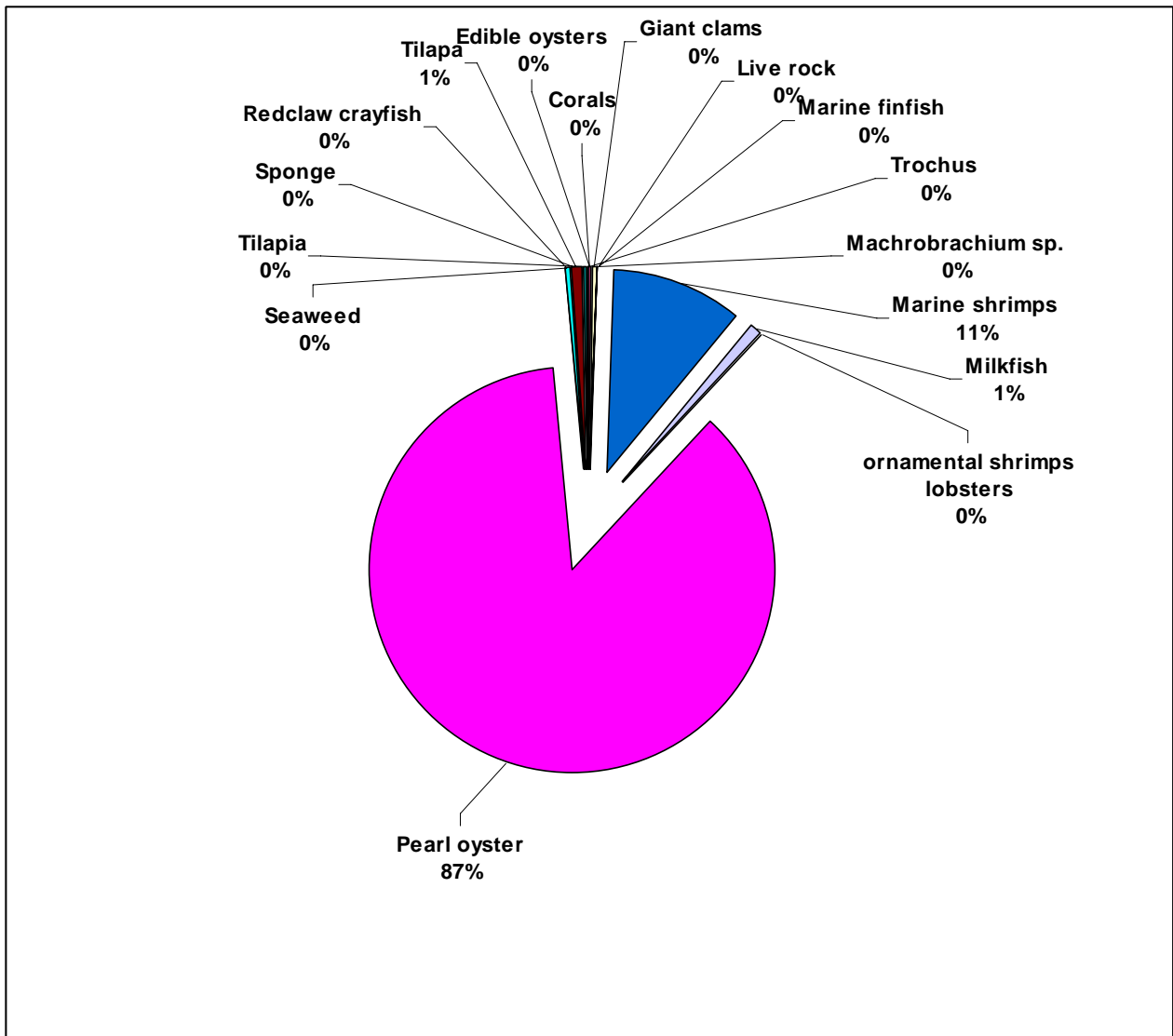
The volume of production is shared more broadly across the region compared to the value. However half of this is attributed to New Caledonia. The rest is made up by a handful of countries with Kiribati, Fiji and the Solomon Islands almost each making up between 10–20% of the volume amongst themselves. Amongst those islands some high volume and low value commodities dominate production. For example Kappaphycus seaweed which is often compared to copra because it requires large volumes to achieve an economic scale of economy.

Annual volume of aquaculture production (tonnes) per year.



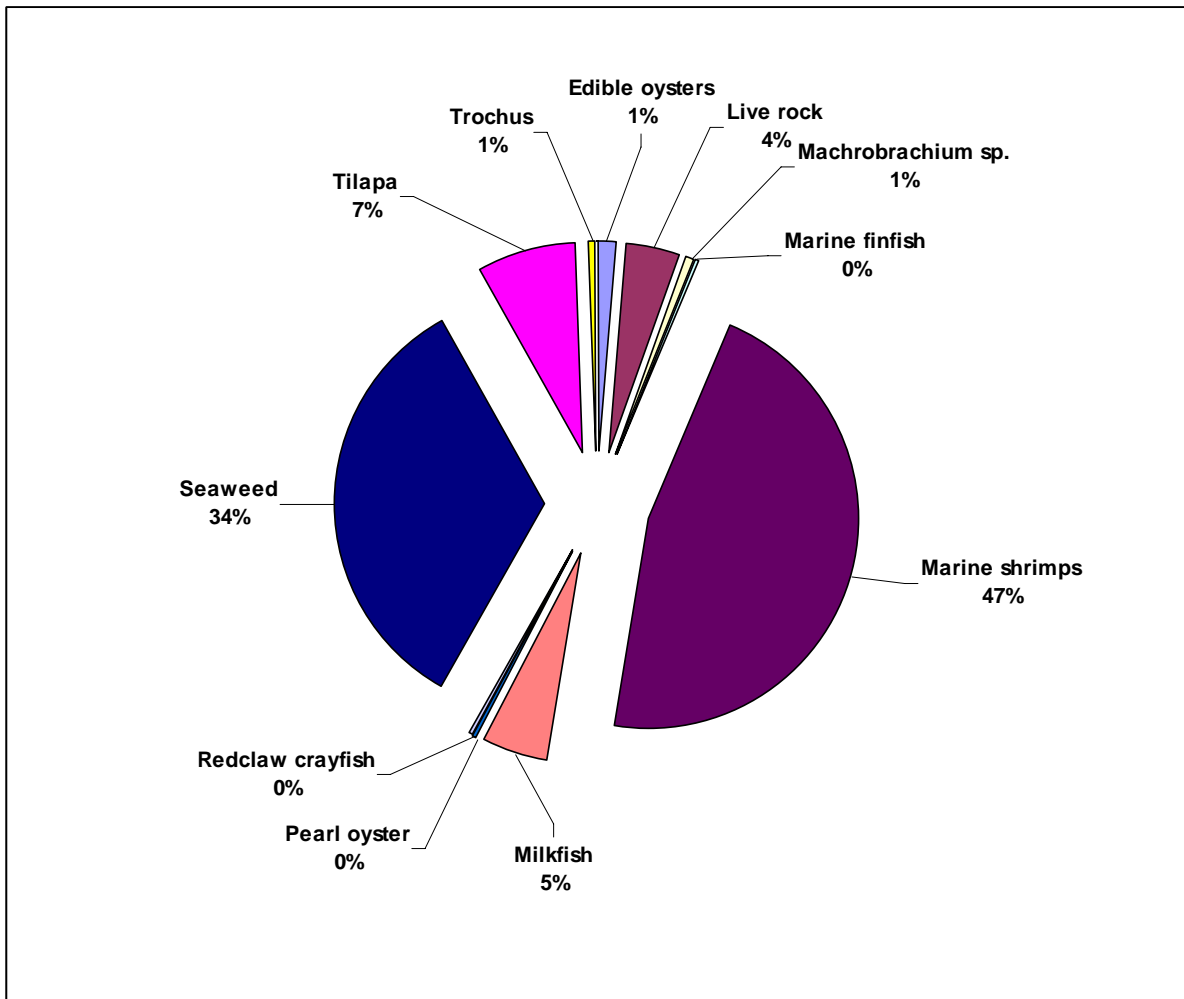
The most valuable commodity produced in the Pacific is culture pearls which account for 87% of the total value of production. This figure may be even greater as it is thought that there are significant sales on the domestic market which is not being accounted for. French Polynesia is the capital of pearl production in the Pacific. The second most valuable commodity accounting for 11% of the total value is marine shrimp which is mainly produced by New Caledonia.

Value of aquaculture commodities produced in the Pacific.



The volume of aquaculture production is broadly shared across five commodities. Almost 50% is accounted by marine shrimp, of which New Caledonia is the greatest producer. Seaweed is also a voluminous product which has been traditionally dominated by Kiribati but more recently overtaken by production in the Solomon Islands where it is exported to France. Tilapia, milkfish and live rock are commodities which collectively throughout the region accounts for more than 200 tonnes per annum produced of each.

Volume of aquaculture production in the Pacific.



Role of aquaculture in livelihoods and food security

The population in the Pacific is expected to grow by almost 50% by the year 2030. The two major focal areas where aquaculture can assist society to meet this challenge is through the provision of livelihoods such as in household cash and through improving food security to ensure a ready access to fish protein and good nutrition.

As a regional bloc, the key livelihood commodities which have been identified as most feasible and having the greatest impact are cultured pearl, seaweed, marine ornamental species, marine shrimp, freshwater prawn, sea cucumber, marine finfish, mud crab and trochus. In the past these commodities were focused on export markets, but the region is also facing increasing urbanisation which will create an expanded domestic market.

- The Pacific is the world's main supplier of cultured black pearls and this is a key economic sector in some countries. Annual exports peaked at USD200 million dollars in French Polynesia and USD15 million dollars in the Cook Islands and then declined as a result of marketing quality controls and disease outbreaks. Although it is a competitive business model, new pearl farms are becoming established elsewhere in islands such as Fiji and Papua New Guinea. One exciting option is mabe (half) pearls which require much less capital and technology investment and could be more feasible for small-scale rural enterprises.

- The marine aquarium trade supplies live fish and invertebrates such as corals and giant clam to aquarium hobbyists, mainly in the U.S, EU and Japan. Around 60,000 cultured giant clams are exported per year. One technique which has been drawing attention is the capture and culture of ornamental post larvae using light traps or crest nets known as PCC (Postlarval Capture and Culture) but this has yet to be proven economically feasible. An immediate challenge facing the industry is that all imports into the EU will require certification from the World Animal Health Organisation (OIE) - of which few Pacific Island countries are a member.
- Farming of marine (Penaeid) shrimp is a massive world trade dominated by production from Asia. New Caledonia is the largest producer in the Pacific with annual exports to France and Japan of around 2,000 tonnes worth around USD20 million dollars. There are opportunities for import substitution on the domestic market for local and tourism consumption. It is estimated the local demand in Fiji is 700 tonnes but less than ten percent is supplied by local farms.
- Freshwater (Macrobrachium) prawn also command premium prices. Because they are relatively easy to grow in ponds and highly marketable it is thought that satellite prawn farms in rural areas could supply larger nucleus operations similar to the chicken grower industry in Fiji. Small pond culture for indigenous Macrobrachium lar offers potential for mono-culture or integrated with swamp taro farming.
- Sea cucumber stocks are in danger throughout the Pacific because their high value in Asia, and their sedentary nature have made them vulnerable to overfishing. Techniques to breed the valuable sandfish species have been developed. However it is unclear to what extent aquaculture can contribute to the restocking of depleted wild stock or form the basis of profitable sea ranching or pond farming systems.
- Kappaphycus seaweed is farmed for its carrageenan extract which is an important ingredient in the food and pharmaceutical industry. Global prices have soared up to USD900 dollars per tonne due to demand from China. Although farming of seaweed is simple and ideal for coastal villagers the costs of freight of large quantities makes it marginally profitable
- Hatchery reared groupers are now a major component of the live reef fish trade in Asia. One of the greatest constraints facing carnivorous marine finfish farming is their feed supply since the fish rely on a high quality protein diet. Herbivorous marine finfish may offer a more suitable alternative to the Pacific Islands.
- In order to maintain the current rate of fish consumption per capita against the growing population, it is expected that an additional 100,000 tonnes of fish will be required. This need will be greatest in rural inland areas where fish consumption rates are already limited by poor access to coastal fisheries. Melanesian countries will face the largest increase in rural inland populations. Commodities such as tilapia and milkfish, which have well established fish farming methods, are amongst the most suitable species to help meet the food security needs of the Pacific people.
- In Asia the Nile tilapia is sometimes referred to as “aquatic chicken” because it is so easy to farm and can provide a protein source for the poor. It can also supply high value markets and

is amongst the top five fish species sold in the United States. Nile tilapia has been sold in municipal markets in Fiji for many years and more recently has proved popular in new countries such as Vanuatu and the Cook Islands. In inland areas it has shown prospects for artisanal and nutrition purposes and many of the estimated 10–15,000 fish farmers in Papua New Guinea are likely to benefit from this fish's farmable traits and marketability.

Cross-cutting issues in aquaculture

Ensuring that aquaculture benefits from advances in technology and marketing will require a constant investment in capacity building through information, training and research and development.

- Information networks have proven to be practical mechanisms for the region to share from each other's past lessons and avoid duplication of effort.
- Several key areas in training for the region include: hatchery and genetics, farm management, disease prevention and management and post harvest food processing.
- Research and development will require coordinated efforts between facilities and teams within the region, access to grant funds, peer reviews and supervision. One critical issue where research is required is in the area of fish feed formulation.

Putting in place the proper strategic institutional frameworks and business climate will require forward planning and policies for sustainable aquaculture and proper economic and marketing analysis.

- There is a need for clear national aquaculture plans. Policy and legislation is required to provide incentives, clarify tenure, licenses, address transportation and support best management practices and quality control.
- Economic analyses must become an inherent part of aquaculture. In addition small business enterprise management, promotion of Pacific products, marketing strategies and advocacy for freight arrangements is essential to ensure profitable aquaculture.

Aquaculture has its role to play in helping to preserve the unique biodiversity that sustains our fishing traditions and ethno-biodiversity. In some instances this could be done directly through promoting the rehabilitation of endangered species. Aquaculture must also take a more holistic "ecosystems approach" so that it does not cause an imbalance to the natural ecology and other human users.

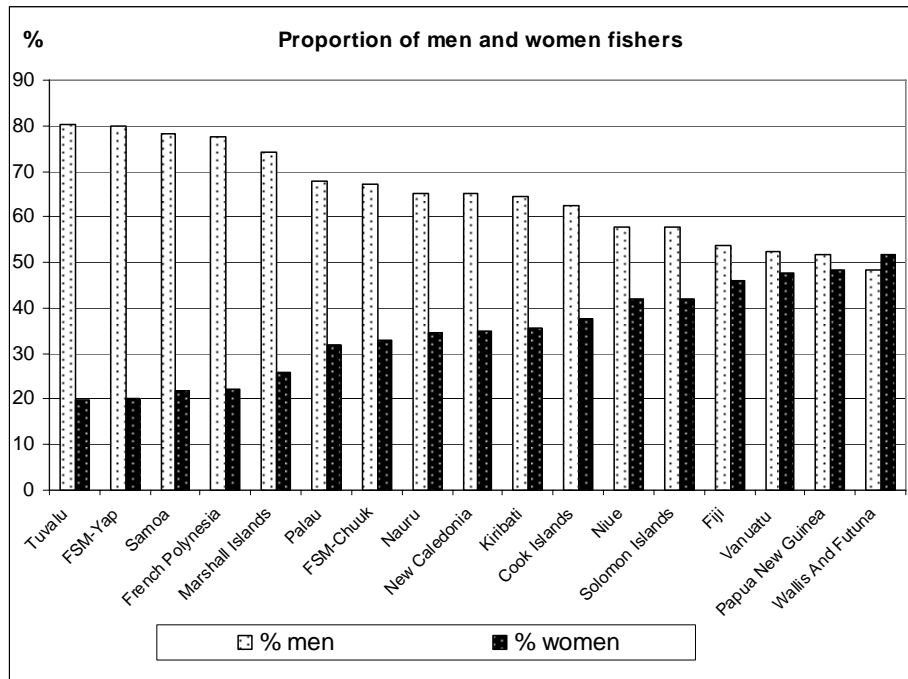
Climate change is a challenge which the region must prepare to face today. As with other primary production sectors, aquaculture needs to assess the type of risks that climate change poses and develop strategies to avoid these risks as well as make the most of the opportunities.

Biosecurity is essential to safeguard the aquaculture environment and its products. The relatively pristine environment of the Pacific has its comparative advantages that need to be maintained. This can be done through responsible trans-shipments and quarantine of live organisms, improved capacity in disease management, maintaining high food safety, and meeting international trade standards. A biosecurity program to support aquaculture will require inter-agency collaboration between fishery, veterinary and quarantine services.

Role of women and men in fisheries

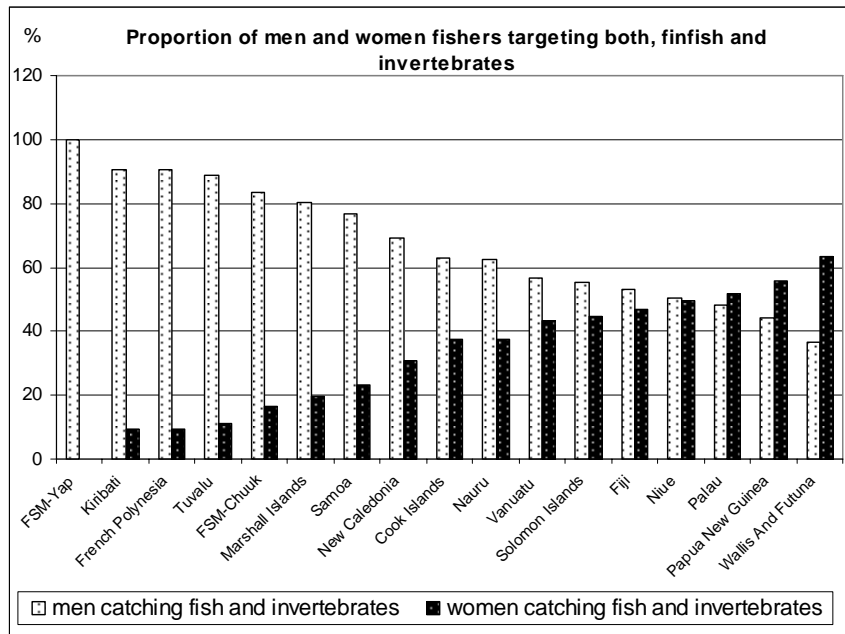
Knowledge of gender roles and their changes are an important input to effective fisheries management, as it allows interventions to be tailored to the needs and ability of specific target groups.

The general dominance of fishermen still persists, as shown in the figure below. This dominance is particularly visible in regard to gender participation of exclusive finfishers only. The opposite is true for exclusive invertebrate fishers, still a women's domain.



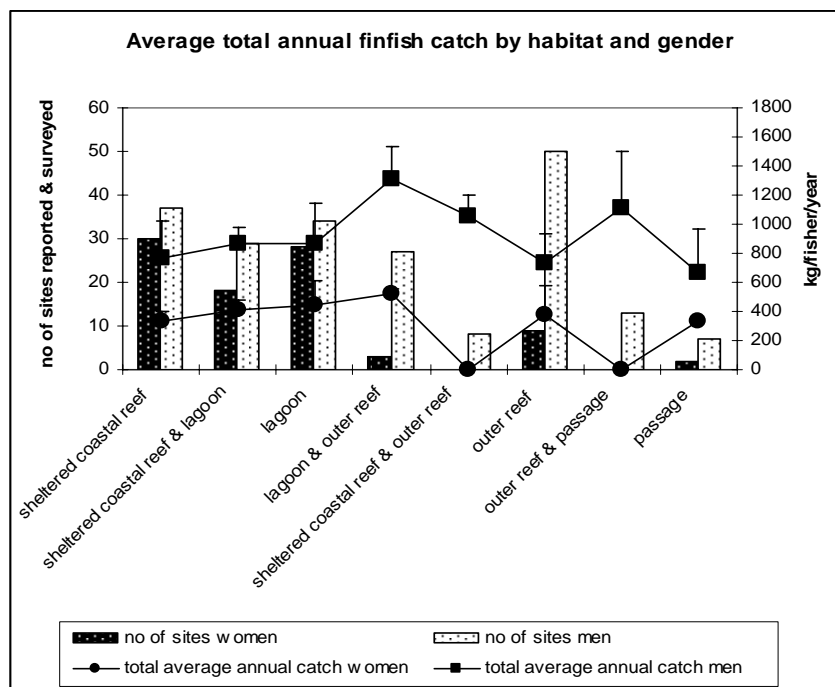
Proportion of men and women fishers by country

However, if we compare the participation of men and women doing both, finfishing and invertebrate collection (not necessarily at the same time though), three groups emerge in the figure below. Fiji, Papua New Guinea, Solomon Islands, Niue, Wallis and Futuna, and Palau, where the ratio between men and women fishers is comparable; New Caledonia, Vanuatu, Nauru, Cook Islands, and perhaps Samoa, where women's participation is significantly less than men's; and finally Yap, Kiribati, Tuvalu, Marshall Islands and French Polynesia with either no or very little participation of women in fishing activities.



Participation (%) of men and women fishers who target both, finfish and invertebrates

There are many ways to present or analyses the socioeconomic data collected for both men and women fishers. An example of this is to use the available information on average annual catch per women and men finfishers for the various habitats targeted (see figure below), where different fishing objectives become obvious. Women mostly participate in easy accessible and less distant habitats. Usually, women fishers have much lower average annual catch rates which underpins that their main interest is not income maximisation but food supply.



Women and men finfisher participation and catch rates by habitat targeted (average figures across all PROCfish/C sites surveyed)

Plans for future versions of this report

As stated in the introduction to this report, this is a first overview of the status of Pacific Island coastal fisheries and aquaculture themselves. There are thousands of stocks of finfish and invertebrates and these cover 22 Pacific Island countries and territories, so it is impossible to assess coastal resources the same as oceanic (tuna) resources.

This report is a 'work in progress' which will be updated and presented to the SPC's CRGA later in 2008. The next version will also be expanded to cover other relevant areas, which may include the status of monitoring and management systems, current trends, and the status of regional and national institutions.

The updating process will continue as more results become available from the analysis of PROCfish/C data, and these will be included in the 2009 report. However, the 2010 report may not be an improvement if the Reef Fisheries Observatory statistical collection and resource survey capacity is lost due to funding limitations, and national monitoring continues to be almost non-existent.

It should also be noted that there is an implicit obligation to report to FAO and the UN on national impact and usage of natural marine resources under national custodianship, and a more comprehensive regional report will help address this.

Recommendations:

This is an information paper prepared by the secretariat of a different organization. However, the members of FFC are all members of SPC, and the exercise of putting it together has raised a number of significant issues. Committee members and Ministers are invited to:

- (a) note the status of nearshore and reef fisheries and aquaculture;
- (b) note that regional and national fisheries agencies are at a new threshold of understanding of coastal fisheries and that continued progress, tracking the excellent advances already made in our understanding of oceanic fisheries, will need continued support. There is a need for resources at both the national and regional level to increase capacity to develop the information systems required for evidence-based decision-making, to both meet the shortfall in subsistence needs and improve livelihood opportunities in national coastal fishery management.

Committee members and Ministers may also wish to:

Note that the work of the SPC's Reef Fisheries Observatory is entirely project-funded and that 95% of the financial support for this work will expire at the end of 2008 with the termination of the EU EDF8 PROCfish and EDF9 COFISH projects.