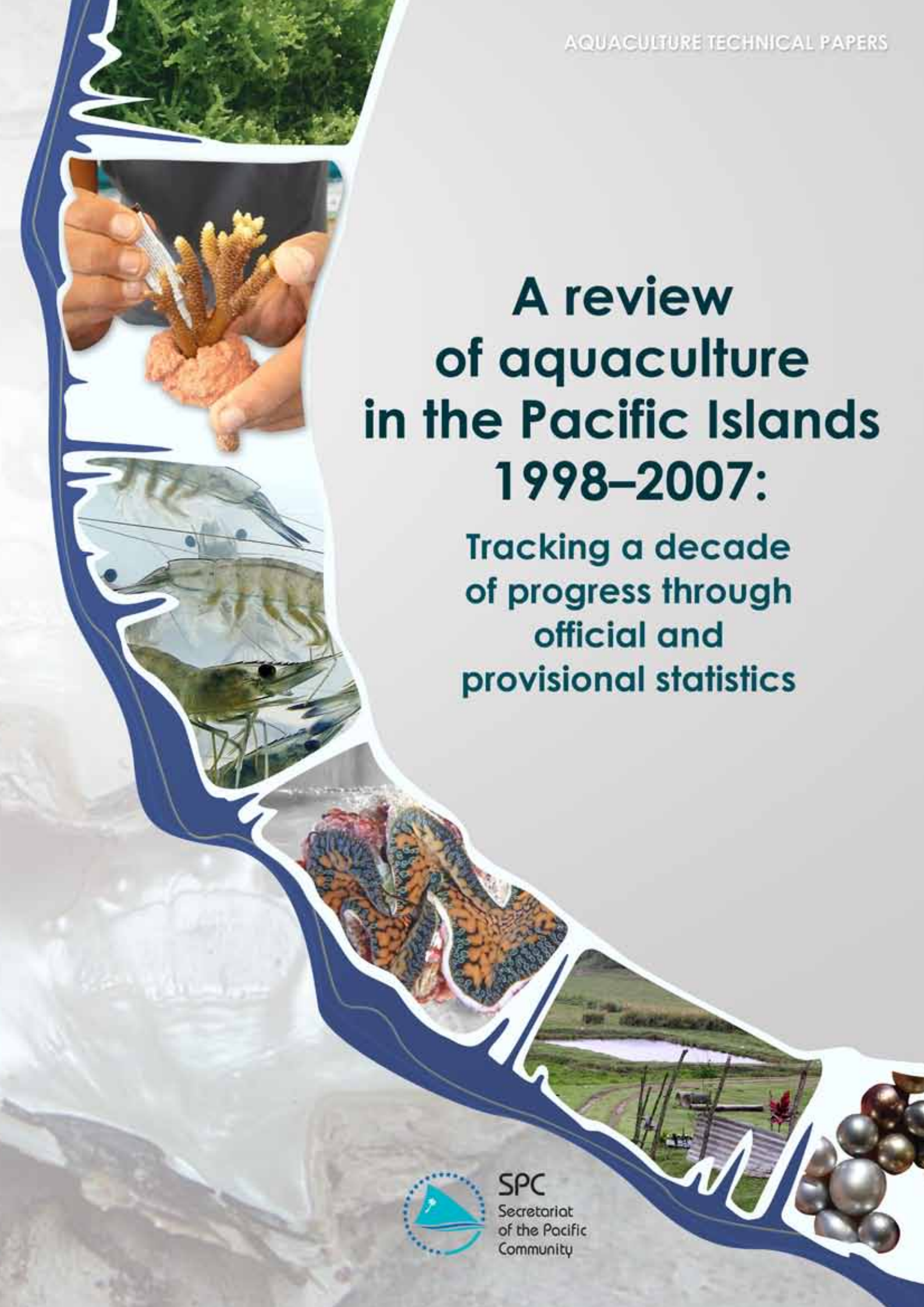


A review of aquaculture in the Pacific Islands 1998–2007:

Tracking a decade
of progress through
official and
provisional statistics



SPC
Secretariat
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Community



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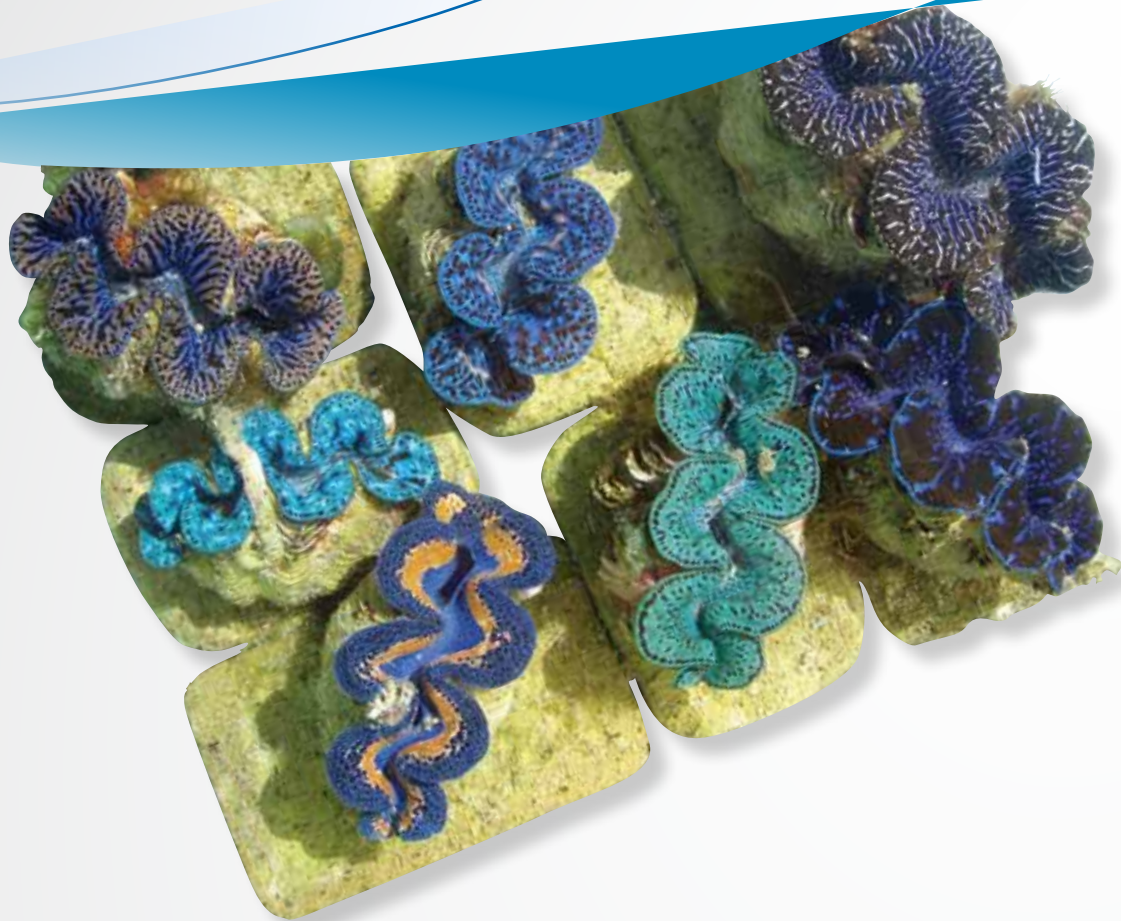
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Executive summary

A provisional desktop review of aquaculture in the Pacific was carried out by the Secretariat of the Pacific Community (SPC) on behalf of its 22 Pacific Island member countries and territories in order to bridge an information gap. During the period 1998 to 2007 a peak value of USD 222 million was recorded in 1999 and in 2005, associated with high levels of pearl and shrimp respectively. The maximum volume was 6,900 metric tonnes (t) in 2005. Amongst the 17 producing countries, the output is dominated by the French territories of French Polynesia and New Caledonia. It is estimated that there are at least 9,000 aquaculturists in the region, but the true number depends on an accurate census of inland fish farmers in Papua New Guinea. The 2007 production value was USD 211 million. This figure, combined with results from a recent fisheries study, suggests that aquaculture accounts for 20 per cent of the total fisheries trade (export and domestic). Given that tuna exports account for a further 60 per cent, the underlying picture is of a region with a limited fisheries economic portfolio in terms of producing countries and commodities. Aquaculture has an important role in diversifying trade, increasing capacity for fisheries production, and contributing to rural development. One of the immediate challenges to overcome is to provide a suitable investment climate for private enterprises.





1. Introduction

The region has a paucity of aquaculture statistics to track the progress of the sector. Government statistics tend to be limited to export data, which is a poor barometer. Fisheries departments occasionally publish production in their annual reports or in reports to the Food and Agriculture Organization of the United Nations (FAO), but statistics are often recycled. The fact that governments are themselves keenly aware of the need for good data in spite of its ongoing scarcity reflects the serious situation concerning the availability of resources and technical services in the region.

The Secretariat of the Pacific Community (SPC) is an inter-governmental development organisation with 22 member Pacific Island countries and territories (PICTs). SPC carried out this regional review to provide a broad assessment of the state of the aquaculture sector to its member governments. The evaluations provided in this report are to be treated as a regional analysis. The report is not to be substituted for official national reporting or statistics.



2. History and challenges to aquaculture in the Pacific

The modern era for aquaculture in the Pacific may have begun with a misstep when in the 1950s Mozambique tilapia from Africa was introduced for mosquito control and for aquaculture. With hindsight we now know that the Mozambique tilapia was the wrong species for cultivation and it never served this purpose. Its widespread invasion in the wild was touted by environmentalists as a red flag for aquaculture.

At this time – before the widespread use of outboard motors, gillnets, etc – the state of fisheries could be considered relatively pristine. With plentiful fisheries resources, there seemed little rationale for aquaculture.

Through the 1960s and 1970s, there was a string of failed aquaculture aid projects. Models introduced from overseas were often incompatible with the local socio-economic conditions. Governments were left with non-functional or monolithic facilities.

By the 1980s, concern was building about the declining state of wild fisheries. Lacking the capacity and resources to prevent overfishing, authorities often turned to the promise of aquaculture and artificial restocking. These efforts gave a false sense of security and excessive fishing continued, probably putting stocks at more risk of serious depletion.

The territories of French Polynesia and New Caledonia were successful after investment of significant resources into technology, financing and marketing, in creating industries for two commodities, blue shrimp and

black pearl. After several decades the large-scale commercial enterprises were established and these French territories were regarded as world leaders in their fields.

By the end of the 1990s, there was a mixed verdict regarding the remaining aquaculture ventures in the region. It appeared that aquaculture (and coastal fisheries) had generally failed to produce sustainable returns. However, the global aquaculture sector took off in the 1990s due to a gap in fisheries supply as the world's major stocks began to plateau. This was facilitated by globalisation of trade, and advancements in science and technology. By 2006, the global production was worth USD 70 billion and provided 46 per cent of all fish consumed (FAO 2009).

In the early 2000s, the Pacific began to re-invest in another phase of aquaculture with more realistic expectations and a greater emphasis on regional networking. This latest phase has the advantage of avoiding the pitfalls of the past by sharing the lessons learned and utilising the growth factors that are propelling the industry globally. As this decade comes to an end there is much speculation about whether the Pacific has been able to capitalise on these opportunities.



3. Survey methodology

Statistical data were initially collected from a desktop search of published and unpublished aquaculture reports. A profile for each country was compiled by SPC and sent to government contacts to review and to fill in gaps or resolve conflicts.

The dataset was made up of the following fields:

1. Country {Categories = PICTs}
2. Category {Category = algal, crustacean, finfish, ornamental, pearl, other}
3. Commodity {Categories = 33 commodities listed}
4. Environment {Categories = brackish water, freshwater, marine}
5. Year {Value = 1998 onwards}
6. Volume {Value = total, domestic, export; Units = pieces, tonnes}
7. Value {Value = total, domestic, export; Units = local currency, USD}
8. Number of farms {Value = total, large, small}
9. Employment {Value = total, full time, part time}
10. Gender {Categories = %male, %female}
11. Centres of production {List = name}

Production figures were reported in the equivalent US dollar farm-gate values. Volumes were quantified either in terms of product weight (raw, dried or processed) or individuals (pieces), depending on the industry standard. Although records up to 2009 were provided, the most recent completed dataset was for 2007; therefore, this was treated as the most current estimate.



4. Results

Although there was a generally positive response to the request for data, much information was missing, especially for domestic sales and employment. If values for known production were not provided, an SPC 'best estimate' was made based on expert opinion. This introduces a possibility for bias. Thus, the data should be viewed as provisional until the estimates can be replaced with official statistics.

4.1 Production by country

The value of aquaculture production in 2007 was USD 211 million (Figure 1). The territories of French Polynesia (USD 174 million) and New Caledonia (USD 29 million) are the major producers and set the overall trend for the region. Peak production of USD 222 million was reached in 1999 and 2005, reflecting the maximum values for French Polynesia (USD 190 million) and New Caledonia (USD 37 million) respectively (Table 1).

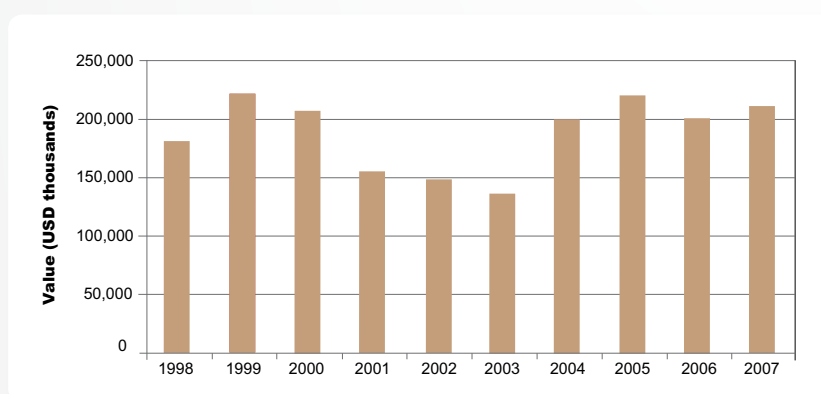


Figure 1. Annual value of aquaculture production (USD thousands)

Table 1. Annual value of aquaculture production per country (USD thousands)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
American Samoa										10
Cook Islands	6,315	6,898	8,641	6,337	3,246	1,836	2,419	1,700	1,917	2,473
FSM							49	205	200	
Fiji Islands	217	610	473	232	44	11	615	1,459	1,010	2,244
French Polynesia	155,290	189,597	175,695	125,565	123,550	110,197	160,540	179,571	162,885	173,598
Guam	757	798	819	819	874				1,231	1,391
Kiribati	421	681	876	896	969	593	762	792	317	17
Marshall Islands	4	16	77	85	71	96	90	78	103	128
Nauru									30	15
New Caledonia	16,230	21,833	19,250	20,075	19,176	22,725	34,130	36,647	31,048	28,835
Northern Mariana Islands									228	205
Palau						6	24	31	14	24
PNG	1,477	1,193	944	1,191	803	852	1,366	1,070	1,182	1,725
Samoa										33

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Solomon Islands	214	211	306	237	1	11	59	90	42	74
Tonga	141	105	170	134	190	101	177	174	128	180
Vanuatu						5		3	426	495
Total	181,065	221,942	207,251	155,571	148,924	136,434	200,182	221,663	200,766	211,646

Progress in 2007 has been mixed amongst other PICTs. Cook Islands is emerging from a slump since its peak of USD 9 million in 2000. The other main producers are Fiji Islands, Guam and Papua New Guinea (PNG). Kiribati has declined to its lowest level of production compared to the USD 1 million it produced in 2002. In 1999, there were only 10 PICTs with production that could be considered commercial. In 2007, that number had increased to 17.

In the period 1998 to 2007, the cumulative value of aquaculture harvested in the region was almost USD 2 billion (USD 1.89 billion). French Polynesia accounted for USD 1.56 billion and New Caledonia USD 250 million. Over this period, the value of production from Cook Islands was USD 40 million, from PNG it was USD 11 million and from Fiji Islands, Guam and Kiribati it was USD 6–7 million each.

In terms of weight, the peak volume of commodities produced in the region was 6,900 t, produced in 2005. In that year French Polynesia, New Caledonia and Solomon Islands reported their maximum values (Table 2). The total tonnage for 2007 is 5,342 t.

Table 2. Volume of aquaculture production (t)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Cook Islands	1	23					25	2	2	186
Fiji Islands	263	649	639	340	80	20	110	153	142	323
French Polynesia	615	918	822	888	1,346	1,339	1,904	2,982	2,475	2,464
Guam	221	231	233	233	233				163	162
Kiribati	743	1,171	1,597	1,356	700	670	820	927	254	
Nauru									8	8
New Caledonia	1,569	1,906	1,724	1,816	1,818	1,649	2,099	2,449	2,288	1,843
Northern Mariana Islands									16	14
Palau							1		1	2
PNG	72	59	28	111	62	98	46	76	47	191
Samoa										10
Solomon Islands	13	13	15	15		40	214	326	169	108
Tonga		36	60							
Vanuatu									18	31
Total	3,497	5,005	5,118	4,759	4,239	3,815	5,219	6,914	5,582	5,342

As explained in the methodology some commodities are quantified by countries in terms of pieces. The maximum amount reported was 575,000 pieces in 2000. This was mainly due to production in Cook Islands and Tonga (Table 3). In 2007, 383,000 pieces were produced.

Table 3. Volume of aquaculture production (pieces)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Cook Islands	303,000	328,000	405,000	325,000	201,000	99,000	128,000	146,000	174,000	149,000
FSM				1,000			10,000	16,000	31,000	
Fiji Islands	4,000	11,000	3,000	2,000	1,000	1,000	50,000	35,000	33,000	54,000
French Polynesia			5,000	26,000	44,000	56,000	20,000	4,000	6,000	2,000
Kiribati					1,000	1,000			1,000	2,000
Marshall Islands	1,000	4,000	6,000	8,000	15,000	20,000	18,000	28,000	28,000	34,000
Nauru										
Palau						2,000	8,000	11,000	31,000	34,000
PNG	30,000	30,000	26,000	32,000	29,000	29,000	44,000	33,000	36,000	46,000
Solomon Islands	10,000	9,000	15,000	5,000	1,000	1,000	2,000	3,000	9,000	17,000
Tonga	29,000	28,000	119,000	51,000	33,000	12,000	26,000	16,000	10,000	17,000
Vanuatu						1,000		1,000	3,000	3,000
Total	374,000	407,000	575,000	446,000	322,000	218,000	294,000	284,000	343,000	383,000

4.2 Production by commodity

Pearls are the region's most valuable commodity (Figure 2). In 2007, the production was worth USD 176 million. The pearl oysters farmed in the Pacific include black-lipped pearl oyster (*Pinctada margaritifera*), silver-lip oyster (*Pinctada maxima*) and winged oyster (*Pteria penguin*), although black pearls from *P. margaritifera* make up the bulk of production.

Crustaceans make up the second most valuable commodity. In 2007, they were worth USD 31 million – mainly from marine shrimps but with some contribution from freshwater species. The crustacean species farmed are blue shrimp (*Litopenaeus stylirostris*), giant tiger shrimp (*Penaeus monodon*), white shrimp (*Litopenaeus vannamei*), giant freshwater prawn (*Macrobrachium rosenbergii*), monkey river prawn (*Macrobrachium lar*) and red crawfish (*Cherax quadricarinatus*).

Algal culture consists mostly of kappaphycus seaweed (*Kappaphycus alvarezii*). The 2007 harvest was a low point for the region. In the past, mozuku seaweed (*Cladosiphon* sp.) has been intermittently cultivated in Tonga.



Figure 2. Annual value of commodity production (USD millions)

Finfish production in 2007 was 464 t worth USD 2 million. This was mostly composed of Nile tilapia (*Oreochromis niloticus*) worth USD 1.3 million and milkfish (*Chanos chanos*) worth USD 0.3 million. Carp (*Cyprinidae*), catfish (*Clarias* spp.) and trout (*Onchorynchus mykiss*) harvests were each worth USD 60,000–70,000. Thirty thousand live milkfish fingerlings were sold in Palau as baitfish. Mozambique tilapia (*Oreochromis mossambicus*) is also harvested from ponds, but no statistics on volume are available. The most finfish the region has harvested in any year was 612 t in 2000, mainly consisting of Nile tilapia.

In 2007, there were 103,000 pieces of ornamental species cultured worth USD 478,000. 80 per cent of the value was made up by the 68,000 pieces of giant clam and 10 per cent of the value was from 28,000 pieces of cultured corals. Culture of ornamental fish post-larvae captured in the wild peaked in 2003 when 56,000 fishes were exported but declined to just over 1,000 pieces in 2007.

In the 'other' category, the 2007 production was mostly from crocodile (*Crocodylus novaeguineae*, *C. porosus*) worth USD 1.3 million and consisting of 35,000 skins and 54 t of meat. The other main commodity was edible oysters (*Crassostrea gigas*) worth USD 0.6 million with a quantity of 110 t.

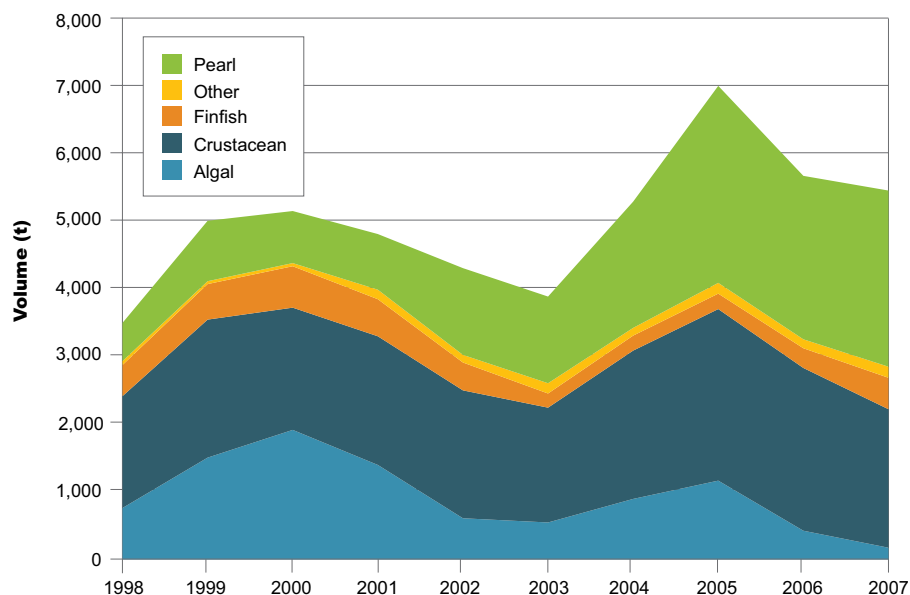


Figure 3. Annual volume of commodity production (t)

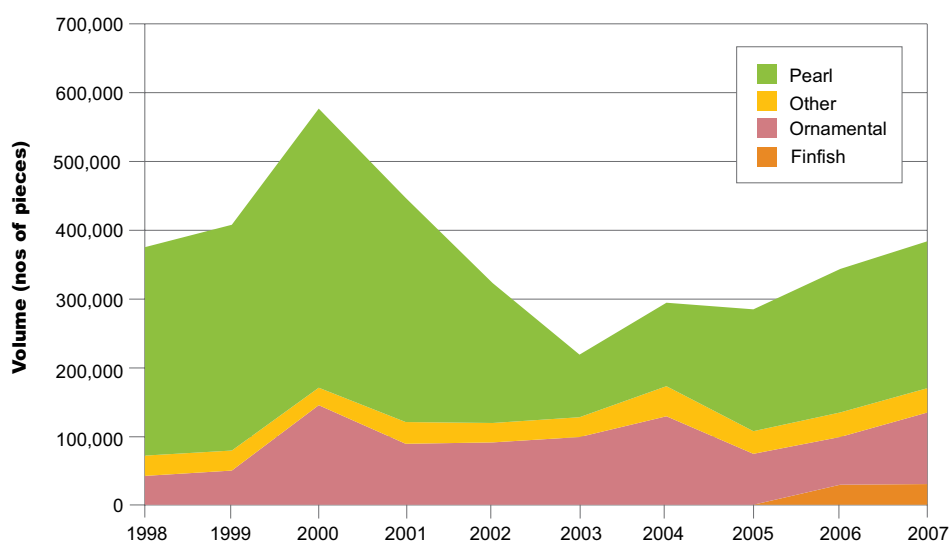


Figure 4. Annual volume of commodity production (pieces)

4.3 Production of key commodities amongst PICTs

4.3.1 Black pearl in French Polynesia

In 2007, the pearl production from French Polynesia was valued at USD 173 million (Figure 5). This accounts for 98 per cent of the total value of production in the region.

Pearl statistics are normally based solely on export figures provided by the Institut de la statistique de la Polynésie française (ISPF). The SPC figures used in this report differ from the ISPF figures because they take into account additional data including the following:

- Unreported pearls, which the Institut d'Emission d'Outre-Mer (IEOM) (2007) estimates to be about 20 per cent of raw pearls. This has been assumed for the period 2004–2007.
- Domestic production, which IEOM (2007) estimates to be about 10 per cent of raw pearls.
- Inclusion of worked pearls including keshi and mabe. From 1998 to 2000, ISPF categorised pearls as either raw or worked. From 2001 onwards, the worked classification was expanded to include keshi, mabe and pearl jewellery. The first three classes are predominantly pearl pieces and so were included in the totals. The pearl jewellery classification was excluded.
- Mother-of-pearl (MOP) exports from the Service de la pêche (SPE) annual statistical reports.

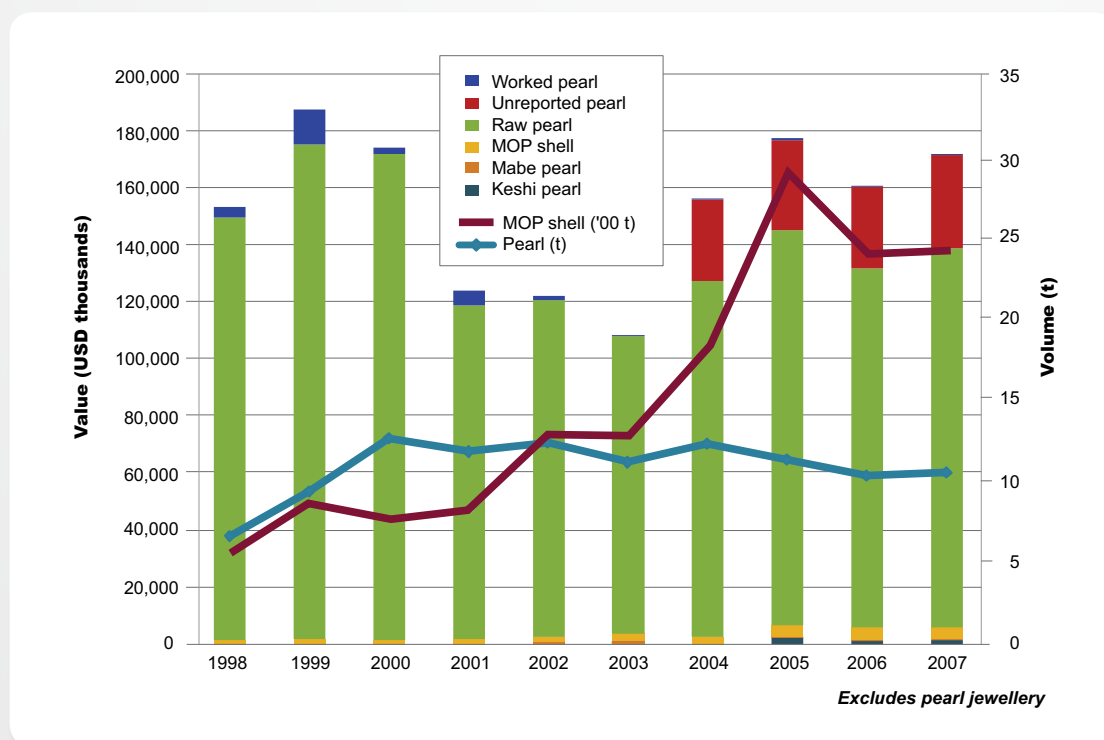


Figure 5. Pearl production in French Polynesia

The French Polynesia pearl industry has had two peaks. The first was in 1999 with USD 189 million earned. Continued mass production – 12.7 t in 2000 – led to a collapse in the price per unit value. Measures by government to limit quantity and focus on quality appear to have arrested this decline to some extent (Tisdell and Poirine 2008; Southgate et al. 2008). After a brief period of consolidation, a second peak occurred in 2005 with USD 178 million earned. It is not clear to what extent these sales included stockpiles from previous year's harvest. But the export volumes of MOP shell increased dramatically in this period, up to 2,900 t, suggesting that large-scale farming must have been occurring.

The 2007 value included 'unreported' sales, which are assumed to be 20 per cent of the official statistic. Adding further ambiguity to the situation is the exclusion of pearl jewellery exports, which according to ISF have gone from just USD 0.5 million (or 150 kg) in 2004 to USD 18 million (1.6 t) in 2007. Together, these data suggest more underground sales but at the same time a shift towards value adding opportunities.

4.3.2 Pearl production from countries other than French Polynesia

The main producer of black pearl, aside from French Polynesia, is Cook Islands. However, poor farm management practices led to a mass mortality from a disease in 2000 (Diggles and Hine 2001), causing sales to drop from USD 9 million to USD 2 million by 2003. In 2007, production appears to have stabilised, albeit still at low levels. Recovery is attributed in part to the country's vibrant tourism market and after reviewing the census and export data on hand it is estimated that domestic sales have risen from 10 per cent in 2000 to about 30 per cent in 2007.

In 2007, an additional five PICTs were producing pearls at commercial levels, bringing the total value to USD 3.9 million. The significant new entrant is Fiji Islands (USD 1.2 million). One positive development is that the range of pearls is beginning to diversify and now includes white 'south-seas' pearl from PNG and purple coloured *Pteria* mabe pearl from Tonga (Figure 6).

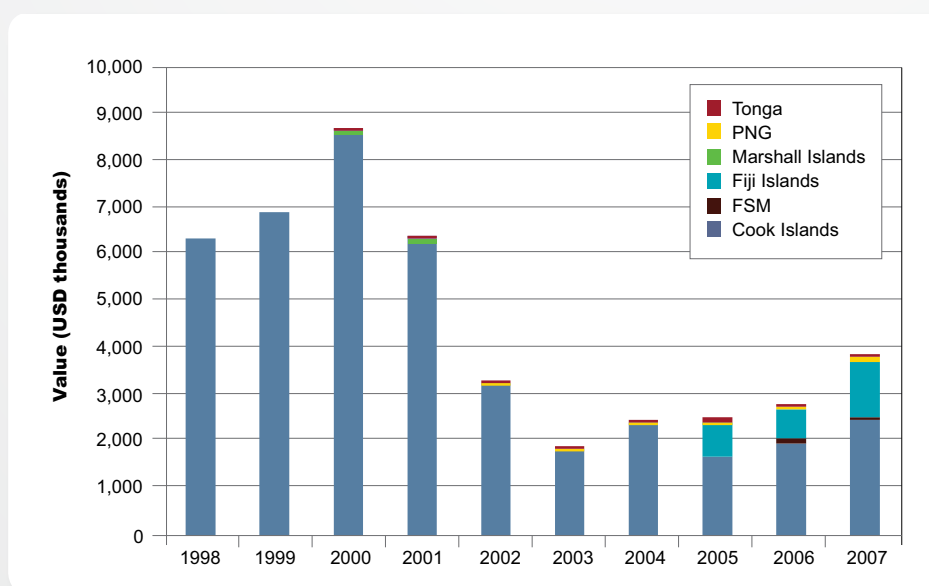


Figure 6. Regional pearl production (excluding French Polynesia)

4.3.3 Marine shrimp in New Caledonia

The introduced blue shrimp is the only species farmed in New Caledonia. The production in 2007 was 1,800 t worth USD 28 million (Figure 7). This is 90 per cent of the region's total production of marine shrimp.

New Caledonia's shrimp industry is often valued based only on the export data from the customs department (Direction Régionale des Douanes) and reported by Institut de la Statistique et des Études Économiques (ISEE). However, the values in this report also include the domestic sales recorded by the Service de la Marine Marchande et des Pêches Maritime (SMMPM).

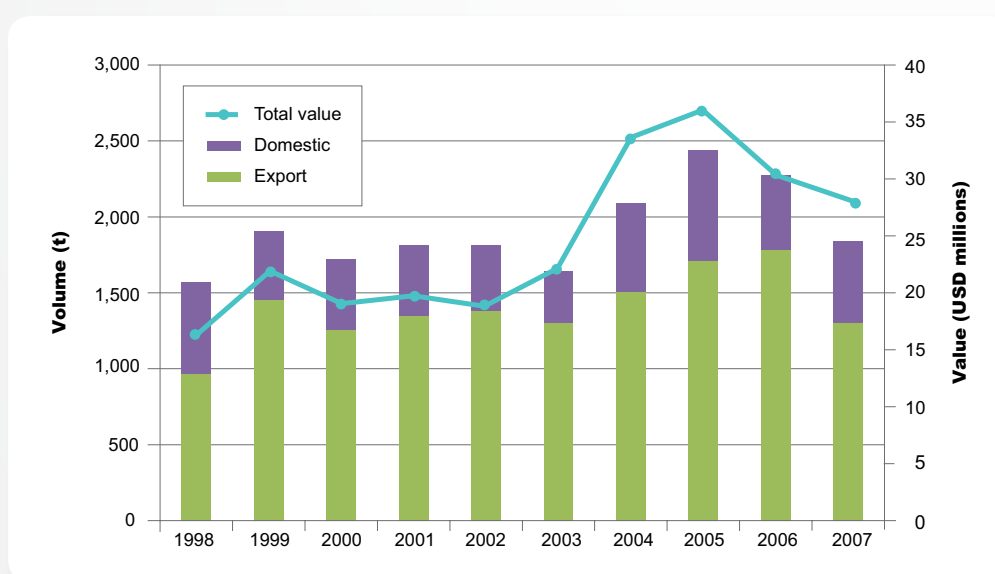


Figure 7. Marine shrimp production in New Caledonia

The peak harvest was achieved in 2005, with 2,400 t worth USD 36 million. There is increasing competition from Asia and South America for the valuable export markets in Japan and France. The 2007 production was affected by issues related to disease, genetics and larval supply (IFREMER 2008).

4.3.4 Crustacean farming other than marine shrimp from New Caledonia

Aside from New Caledonia, Fiji Islands and French Polynesia are the main crustacean producers. Recent growth in Fiji Islands has been due to freshwater *Macrobrachium* prawn, whereas French Polynesia is concentrating solely on marine species. New shrimp farms in Vanuatu, Northern Mariana Islands and Guam have also contributed to peak production in 2007 of 204 t worth USD 2.7 million (Figure 8).

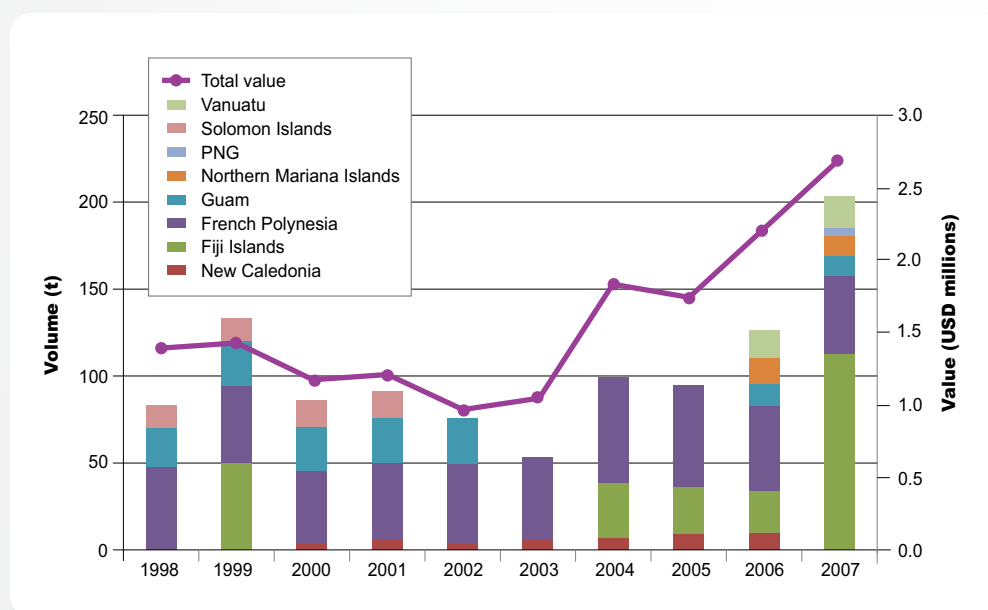


Figure 8. Crustacean production (excluding New Caledonia shrimps)

4.3.5 Giant clam and coral farming for the ornamental trade

The cultivation of giant clam and coral is mostly for the ornamental trade, although some product is sold on the curio market, or in the case of giant clam, for its meat. Greater conservation awareness has shifted consumer preference towards cultured products. Aquaculture products are also exempt from export restrictions imposed by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

The Pacific is a major supplier of giant clams on the world market and is becoming a leader for coral as well (Kinch and Teitelbaum 2009). The global demand for giant clam was thought to be 200,000 pieces per annum in 2007, of which the Pacific provided 69,000 pieces. The main producers are Federated States of Micronesia, Marshall Islands and Tonga. Ten thousand pieces of farmed coral were exported by Solomon Islands and Marshall Islands in 2007. Fiji Islands is a major cultivator of coral but statistics are vague except for one account of 25,000 pieces of coral and 50,000 pieces of live rock (Lindsay et al. 2004). The combined value of cultured clams and corals from the region in 2007 was USD 470,000 (Figure 9).

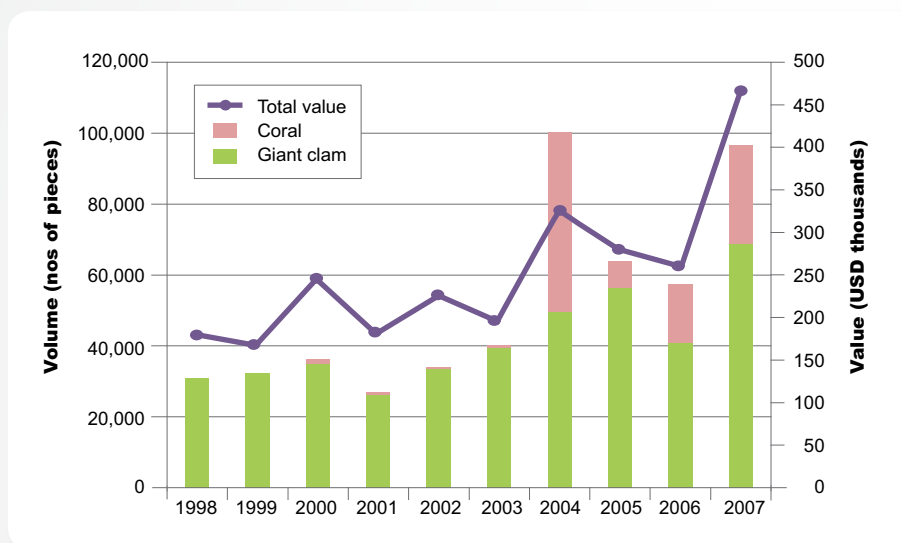


Figure 9. Production of giant clams and corals for the ornamental trade

4.3.6 Kappaphycus seaweed cultivation

Cultivation of kappaphycus (trade name *cottonii*) was once a thriving industry in Kiribati, particularly on Fanning Atoll in the Line Islands (Luxton and Luxton 1999). In 2000, there was 1,400 t of dried seaweed exported to the Philippines. But by 2007 there were no exports, with officials citing unfavourable factors such as high freight costs, poor currency exchange rates, warm water temperatures and inadequate farm management (McHugh 2006). In Fiji Islands, the government initiated widespread seaweed farming with exports rapidly rising to 420 t in 2000. However, many sites chosen were not suitable and after the initial inputs there was a rapid decline (Anon 2007). Seaweed farming in Solomon Islands had modest beginnings but steadily increased to 330 t by 2005. Most of the seaweed comes from Vaghena Island. The original farms at Rarumana Island are no longer operating due to logging impacts and, more recently, uplifting of the lagoon following an earthquake.

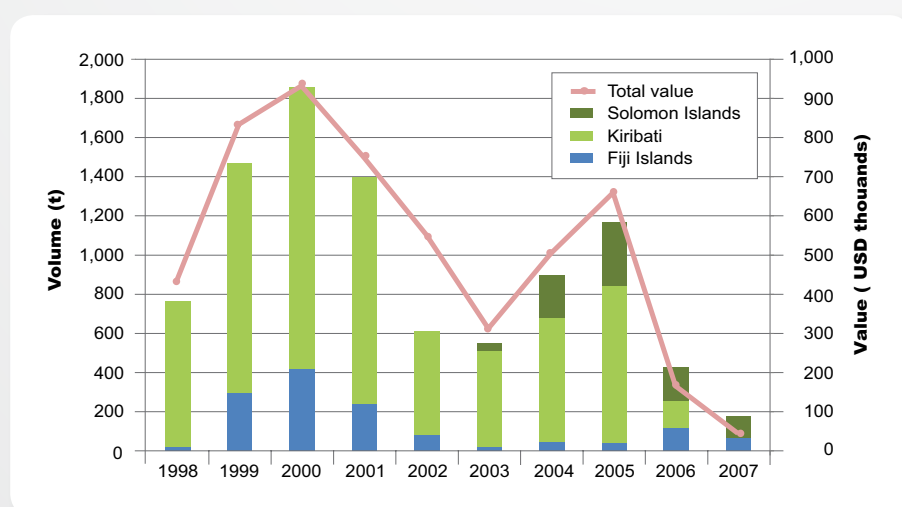


Figure 10. Kappaphycus seaweed production

4.3.7 Tilapia farming

After its introduction in the late 1960s, the Nile tilapia became one of the first species to make the transition to commercial aquaculture in Fiji Islands (Pickering and Forbes 2002). In 2007, 300 t were harvested in Fiji Islands. Guam is also a consistent producer and harvests 100–150 t per year. In 2007, more PICTs reported commercial farming of tilapia, including Vanuatu, Samoa, American Samoa, Cook Islands and Northern Mariana Islands. Farming levels in PNG are thought to be in a growth phase, with 2007 production estimated at 100 t¹ (Figure 11).

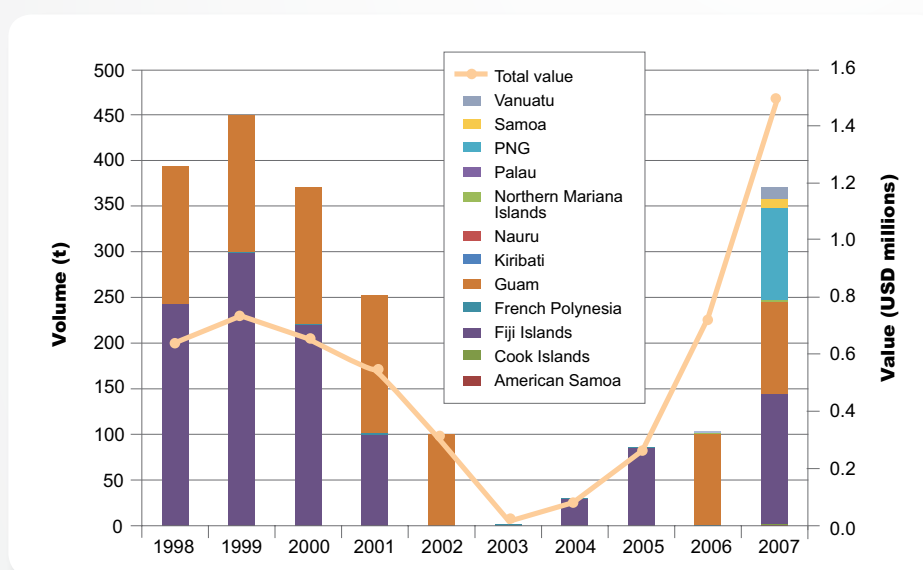


Figure 11. Tilapia production

4.4 Export and domestic markets, food security and import substitution

In 2007, aquaculture commodities are export oriented, with exports comprising 85 per cent of the value and 70 per cent of the volume of total production. Major markets include: Hong Kong, Japan, Europe and the United States (US) for pearl; Japan and France for marine shrimp; US, Japan and Europe for ornamental species; and the Philippines and France for kappaphycus seaweed. There is little evidence in the region of cooperation in inter-regional trade.

There are major opportunities for import substitution. For example in marine shrimp, French Polynesia imports around 500 t but produces 50 t (IEOM 2007). Fiji's consumption is around 900 t and it imports around 600 t (FTIB 2009). The high costs of feed and poor supply of juveniles are the major impediments to meeting this demand. The low price of imported shrimp is also a factor.

¹ According to the National Fisheries Authority (Minimulu pers. comm.), a farmer census underway suggests that there may be 10,000–20,000 household farms in PNG – a tremendous increase over the values used in this review.

In 2007, 1,230 t of edible product was sold locally (Figure 12). This mainly consisted of marine shrimp but also included another dozen commodities. No estimate of subsistence food aquaculture was made, although traditional aquaculture of milkfish is widely practiced and Mozambique tilapia is removed from backyard ponds for household consumption.

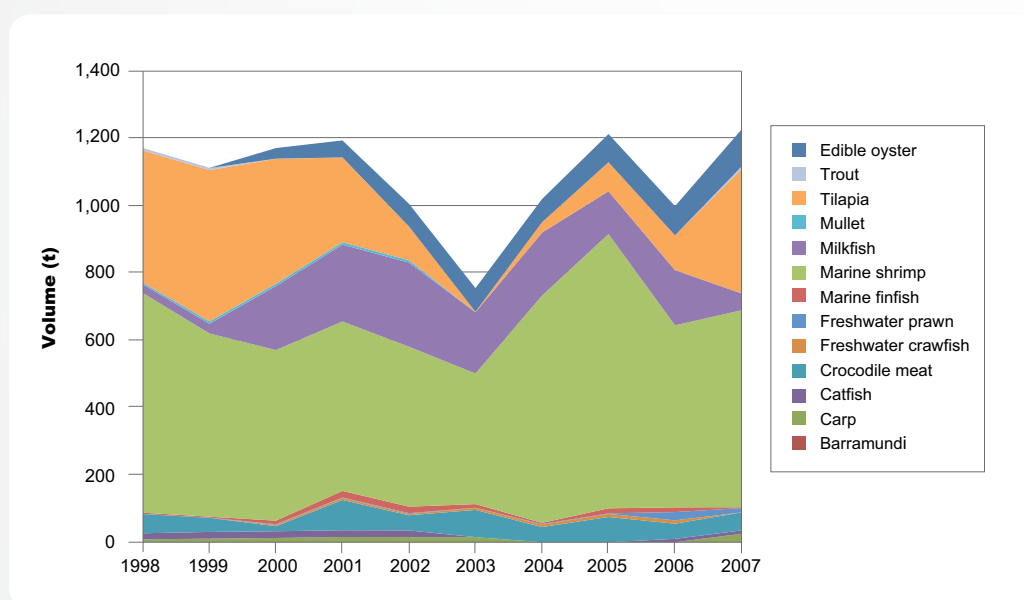


Figure 12. Aquaculture food production for domestic consumption (t)

4.5 Number of farms, employment

There were poor statistics about the number of farm units, employment and gender.

To assess production units in 2007, the analysis was restricted to those countries that are major producers of pearl, shrimp and tilapia, as these tend to be discrete operations. It is estimated that in 2007 there were 3,200 farm units providing livelihood benefits to 9,290 persons (Table 4).

Much depends on the accuracy of PNG estimates, which are conservative based on an Australian Centre for International Agricultural Research (ACIAR) survey (2007) that reported 5,418 operational farms among the 10,000–15,000 existing fish ponds.

Table 4. Number of farm units and persons involved in aquaculture

	Farm units	Persons
Cook Islands	80	450
Fiji Islands	50	280
French Polynesia	530	5,000
New Caledonia	40	560
PNG	2,500	3,000
Total	3,200	9,290

4.6 Contribution to economic development (gross domestic product, income, trade)

The economic contribution of the aquaculture sector was assessed using two different measures – firstly in terms of contribution to gross domestic product (GDP) and secondly in terms of income generation.

Contribution to GDP was measured using the standard production approach. This is calculated by multiplying a value added ratio (VAR) by total production. The VAR is determined by subtracting intermediate costs such as fuel and feed from total costs and dividing remaining costs (such as labour, fees and capital) by revenue. By querying the SPC aquaculture economic modelling software for standard farm configurations it was possible to derive VARs for key commodities. Estimated VARs were highest for seaweed (0.95), intermediate for pearl (0.77) and lowest for marine shrimp (0.49). When these results were applied to the 2007 production figures, a total GDP contribution of USD 154 million was calculated (Table 5).

To estimate income, a formula was devised which involves taking the product of income streams (wages, profit) divided by revenue, then multiplying by production to calculate income. The result for 2007 is that the sector contributed USD 120 million worth of income to the region (Table 5).

Table 5. Aquaculture's contribution to GDP and income in 2007 (USD thousands)

Sector	Scenario	VAR	GDP	Income
Algal	Kappaphycus seaweed farm	0.95	40	40
Crustacean	Shrimp farm (10 hectare)	0.49	15,000	11,000
Finfish	Tilapia farm (1.5 hectare)	0.69	1,000	1,000
Ornamental	Giant clam and coral (500 m ²)	0.77	400	300
Other			1,000	1,000
Pearl	Pearl farm (100,000 oyster)	0.77	136,000	107,000
Total		0.73	153,440	120,340

5. Discussion



5.1 Production between countries and commodities

Aquaculture production in the region is currently worth USD 211 million, with a cumulative harvested value since 1998 of USD 1.89 billion.

Regional trends are dictated by production in the French territories. The first peak in value of USD 222 million in 1999 was driven by the boom of the pearl industry in French Polynesia. A second peak in 2005, also of USD 222 million, reflects high shrimp output in New Caledonia. Both of these commodities are also major contributors to the maximum volume produced in the region of 6,900 t in 2005. However, pearls, the most valuable commodity, comprises a small portion of the volume – on average around 10 t.

The governments of the French territories have invested decades of research and marketing into their sectors and aquaculture is prominent in national policy. Subsidies play an important role in alleviating the financial risk for the private sector and cushioning the impact of external factors. By contrast, other PICTs have had a lack of policy direction and tended towards short-term approaches often on a project basis. This has allowed limited opportunity for technology transfer and creation of the proper investment climate for the private sector.

Nonetheless, in recent years, PICTs appear to be making serious efforts in aquaculture and steady progress is being made. The number of countries and territories with commercial production has risen from 10 to 17 in the past decade. This has also added diversity to the sector. Although the growth in some PICTs is relatively small at a regional scale, the significance at the national level should not be underestimated. Compared to the average output of 2003–2006, there has been a modest growth of around USD 4 million in 2007 from the non-French PICTs.

Pearls and crustaceans are the dominant commodities and, as explained earlier, are linked to the output of the French territories. In 2007, French Polynesia accounted for 98 per cent of the USD 177 million of pearls harvested and New Caledonian shrimp accounted for 90 per cent of the USD 31 million of crustaceans harvested. Whilst pearl output in Cook Islands is still low, new entrants such as Fiji and PNG are becoming established and diversifying the range of pearl products. There is also a positive outlook for crustacean farming in the region, with several large privately owned farms that have started up in recent years.

Perhaps the least performing commodity is kappapycus seaweed. A peak was achieved in 2000 with 1,900 t when the market price was only around USD 500 per tonne. Since then the demand from China and processors avoiding animal carrageen has caused spot prices to soar to the range of USD 2,500 per tonne. Unfortunately the Pacific has not been able to capitalise on this demand, and in fact, seaweed production in 2007 was the lowest on record. PICTs may wish to consider regional approaches to achieve economies of scale in freight, marketing and semi-processing to provide stability in supply and ultimately increase profits.

Although a wide variety of finfish species are being farmed, most of production is from tilapia or milkfish. It is likely that these species will become mainstream commodities in much the same way that

industrialisation of livestock is centred on just a few commodities (chicken, cattle, goat). Whatever cultured fish species predominates at a global level will have a major influence on the choice for the Pacific; it has been estimated that about 3 million t of tilapia are already being farmed globally (Fitzsimmons 2009).

The culture of ornamental products for aquaria has the potential to expand and diversify into a wide range of coral, live rock and post-larval cultured products. However, this growth expectation has to be tempered by reality of the size of market, its demanding and constantly evolving niches and the ability of the Pacific's freight links to service markets.

Amongst the 'other' commodities, the review identified the edible oyster and crocodile as two of the most significant products, noting that these products have quietly sustained themselves.

5.2 Export and domestic trade

In 2007, aquaculture exports were worth USD 182 million and domestic sales were USD 29 million.

Large quantities of pearl and shrimp are exported to markets in Japan, US and Europe, a testimony to the region's capacity to meet the demand from 'high end' markets and overcome trade barriers. The commodity being exported by the largest number of PICTs is giant clam. This is the result of the many government hatcheries operational in the region. It is also testimony to the perseverance of private sector ornamental exporters who have much difficulty transporting the animals alive.

In 2007, domestic consumption of farmed crustaceans, fish and molluscs totalled 1,200 t. The greatest market penetration was achieved in New Caledonia, where on average 500 t of shrimp are sold locally. Although biosecurity restrictions have prevented competition with imported shrimp, it is still a remarkable achievement.

Fisheries data from the 'Benefish report' compiled for the Asian Development Bank (Gillett in press) and this survey indicate trade in fisheries and aquaculture in 2007 was USD 1.065 billion. From this total, exports accounted for USD 875 million and domestic sales USD 190 million.

This trade includes the following categories: tuna exports (60 per cent); other oceanic and coastal fishery exports (5 per cent); aquaculture exports (17 per cent); capture fisheries domestic sales (15 per cent); aquaculture domestic sales (3 per cent). In summary, capture fisheries accounted for 80 per cent of the total and aquaculture the remaining 20 per cent.

Interestingly, as in the aquaculture sector, fisheries production was skewed to just a few PICTs, with a notable presence of territorial states. For example 65 per cent of total fisheries exports consist of canned tuna from American Samoa alone, and it increases to 75 per cent if PNG is included. 44 per cent of commercial domestic fisheries sales appear to occur within just two countries: Fiji Islands and French Polynesia (Table 6).

Table 6. Fisheries and quaculture export and domestic trade (USD thousands)

Country	Export values			Domestic values	
	Tuna	Other oceanic and coastal fisheries	Aquaculture	Fisheries	Aquaculture
American Samoa	431,479			166	10
Cook Islands	2,301	46	1,775	1,067	699
FSM	11,156	1,117	201	7,568	
Fiji Islands	41,663	21,393	1,083	38,038	1,161
French Polynesia	5,459	151	160,166	45,643	13,433
Guam				195	1,391
Kiribati		1,597	17	4,958	
Marshall Islands	14,300	450	128	2,450	
Nauru			-	841	16
New Caledonia	2,322	5,863	17,556	9,069	11,280
Niue				59	
Nothern Mariana Islands				950	206
Pitcairn Islands				38	
Palau	19,000	92	25	2,751	
PNG	88,000	13,000	1,295	14,028	431
Samoa	7,634			19,558	34
Solomon Islands	19,105	680	74	1,674	
Tokelau					
Tonga	1,407	3,445	106	8,911	75
Tuvalu		5		617	
Vanuatu		1,231	13	889	483
Wallis and Futuna		79		1,129	
Total	643,824	49,143	182,434	160,593	29,213

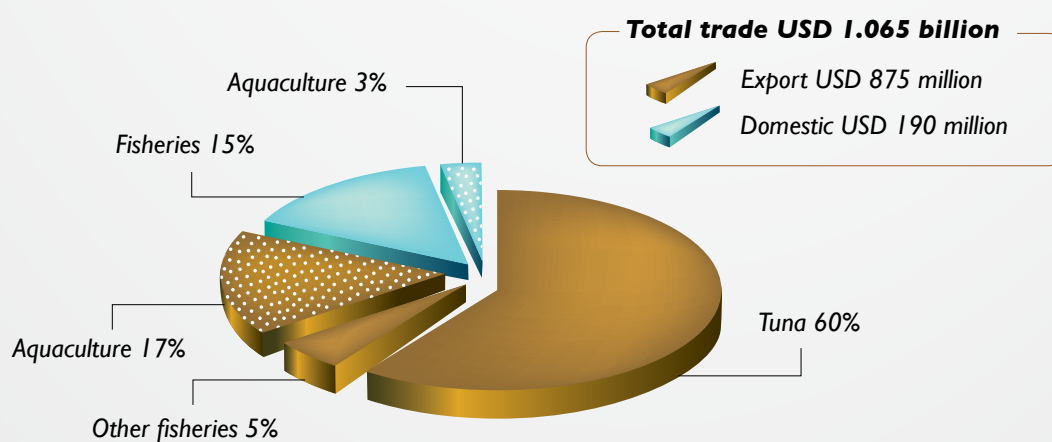


Figure 13. Aquaculture and fisheries trade component for export and domestic markets

Aquaculture currently contributes only a small portion of the fish protein consumed in the region. Even in Fiji Islands, one of the most well established fish farming PICTs, it only contributed 140 t in 2007, compared to domestic sales of reef fish of 4,148 t reported by the Ministry of Fisheries.

The region's demand for fish protein is expected to increase by 50 per cent by 2030 due to population growth alone. This demand combined with a dwindling supply from over exploited coastal fisheries means that there is a gap of 100,000 t of fish, required just to fulfil basic nutritional requirements (SPC 2008). The large rural inland population of Melanesia will be particularly vulnerable to changes in fish supply, but PICTs will have increased rates of urbanisation and so consideration must be given to disenfranchised peri-urban populations as well.

Small pond aquaculture may be one 'vehicle' for providing the additional and renewable source of fish protein required (SPC 2008). And there are already positive signs of uptake in PNG and Vanuatu of introduced Nile tilapia. Capture-based aquaculture of reef or pelagic fish in cages could also be an additional source of fish for urban or rural coastal populations. A practical challenge facing these production systems will be obtaining appropriate ingredients for the feed inputs at reasonable cost.

5.3 Economic contributions

Information to calculate the number of persons employed or directly benefiting from aquaculture was sketchy. A conservative estimate among selected PICTs suggests that at least 3,200 farming units and 9,300 farmers were active in 2007. The accuracy of this estimate depends on the number of fish farmers in PNG.

The contribution to GDP was measured using an approach that values the contribution from production. This amount was estimated at USD 154 million in 2007. Combining this figure with the data on contribution to GDP of capture fisheries from the 'Benefish report' for 2007 gives a total of USD 645 million. Therefore, aquaculture accounts for 22 per cent of total contribution of the fisheries sector's GDP, which is less than that provided by locally-based offshore fisheries (31 per cent), almost on par with the amount from coastal subsistence fisheries (27 per cent), and more than the combined value from commercial coastal fisheries (17 per cent) and freshwater fisheries (3 per cent).

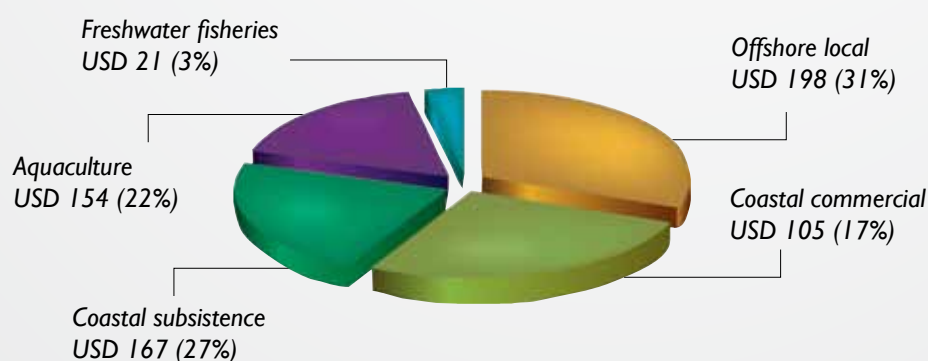


Figure 14. Annual percentage contribution of the various fisheries and aquaculture sectors to gross domestic product, in terms of value (USD millions)

Using GDP figures to compare farming systems such as aquaculture to extractive fisheries (particularly subsistence fishing) does not do justice to the multiplier effects of income that aquaculture generates and the cash economy that the region is striving towards. For example if comparing reef gleaning to a pearl farm, the pearl farm would obviously provide more opportunities for economic growth (services, infrastructure development, skills and etc), then gleaning.

In terms of income generation, aquaculture provides USD 120 million to the region's population. Because many countries have limitations on foreign equity, a high portion of this income is believed to be retained by the local economy. Some of this income actually comes from government subsidies and a cost-benefit analysis should be undertaken to advise governments on whether these subsidies should be viewed as acceptable 'social' taxes or as a drain on their revenue.

5.3.1 Future trends

A situational report as of 2009 suggests that growth in aquaculture is continuing. Indicators include:

- commercial harvesting of pearls in PNG and increased production of pearls in Fiji Islands;
- recovery of New Caledonia shrimp from the 2007 slump; and increased exports of shrimp to US from Northern Mariana Islands and to Fiji Islands from PNG;
- widespread uptake of Nile tilapia in inland PNG;
- increasing exports of cultured corals; Fiji Islands has begun exporting artificial live rock; and
- increases in export of kappaphycus seaweed from Solomon Islands (400 t/yr) and Fiji Islands.

However, there are ominous signs from the pearl industry in French Polynesia. Exports since 2007 are declining. This may reflect the onset of the economic crisis, which has affected global demand and the trade weighted currency exchange rates. It also points to systemic problems within the industry.

Forecasting growth over the next 10 to 15 years is a difficult task. Increasing urbanisation in the region will provide greater opportunities for growth of domestic markets. Population growth will also require aquaculture to play a greater role in food supplies. This demand is likely to be met by just a few domesticated fish species, as has occurred within the livestock sector. But some supply, particularly in rural areas, may come from capture-based aquaculture of coastal and pelagic finfish. If the region can maintain high marine biodiversity, a pristine environment and biosecure status, it may have competitive advantages for niche products and exports, such as ornamentals or brood stock. Opportunities to establish footholds for future markets in China should be explored.

Much of the scope for growth still lies within the established commodities and an optimistic forecast is that the sector could be worth USD 330 million by 2025 (Table 7). Although the pearl and shrimp industries of the French territories have probably reached maximum sustainable levels, other PICTs still

have opportunities to meet domestic demands and expand export markets in their respective sectors by up to USD 55 million per year. Production of at least 10,000 t of fish will only contribute a small portion to the food fish supply required by the region's increasing population (SPC 2008). Live rock, corals and giant clam will probably continue to be the main ornamental products, but a high level of biodiversity should provide opportunities for a greater range of species. World demand for plant-based carrageen will probably continue to outstrip supply, and if the region produces 10,000 t of kappaphycus seaweed it will achieve economies of scale, increasing profits, which will in turn encourage more farming.

Table 7. Past, current and future predicted levels of aquaculture production (USD millions)

	1998	2007	2025
Algal	0.4	0.1	10
Finfish	0.9	2.0	30
Marine shrimp	17.6	31.0	80
Ornamental	0.2	0.5	10
Other	1.4	1.8	5
Pearl	160.5	176.0	195
Total	181	211	330

The forecast for growth in aquaculture is largely based on its market potential. Other global forces present challenges. Although these challenges include climate change, aquaculture is expected to be more adaptive to these impacts than wild reef fisheries and inland aquaculture could be a beneficiary. A critical bottleneck facing the region is inducing the private sector to invest in aquaculture. Outside the French territories, the growth so far has been fuelled by only a handful of entrepreneurs. The lesson learned from French territories is that long-term approaches and a high level of government policy support are required to attract investors and stabilise production. Such support will be difficult for PICTs with small economies.

Key decisions for the region involve, firstly, getting the balance right between government-led development of aquaculture and providing incentives for the private sector, and then, identifying the appropriate scale of operations for the region.

The government-led approach is beginning to pay dividends for large-scale commercial aquaculture in developed countries such as Norway. There is a contrasting model in Asia (which accounts for 90 per cent of the world's production), where economies of scale are achieved through numerous small-scale producers able to dynamically alter their product according to market shifts. The strategy for the Pacific is still evolving, but a middle-of-the-road approach where government maintains regulatory oversight and provides an investment climate focusing on small to medium sized enterprises (SMEs) as a way to 'break out' commercially is probably a prudent approach for the immediate term.

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Table 1. Value of commodities production (USD thousands)

	Algal	Crustacean	Finfish	Ornamental	Other	Pearl
1998	431	17,622	913	179	1,430	160,491
1999	853	23,251	1,024	167	1,141	195,506
2000	964	20,225	1,204	259	1,072	183,527
2001	747	20,934	1,459	288	1,236	130,906
2002	550	19,742	1,350	324	1,131	125,826
2003	310	23,242	447	311	1,282	110,843
2004	501	35,392	463	385	1,876	161,565
2005	656	37,750	660	298	1,654	180,646
2006	162	32,610	1,477	289	1,772	164,456
2007	42	30,859	2,016	478	1,817	176,434
Total	5,216	261,625	11,012	2,978	14,412	1,590,201

Table 2. Volume of commodities production (t)

	Algal	Crustacean	Finfish	Other	Pearl
1998	762	1,652	460	58	565
1999	1,506	2,039	525	43	892
2000	1,916	1,806	612	16	769
2001	1,398	1,901	548	91	822
2002	610	1,890	412	46	1,282
2003	548	1,696	209	82	1,280
2004	896	2,191	222	45	1,865
2005	1,166	2,535	228	75	2,911
2006	426	2,405	291	45	2,415
2007	175	2,046	464	54	2,602
Total	9,402	20,161	3,972	552	15,403

Table 3. Volume of commodities production (pieces)

	Finfish	Ornamental	Other	Pearl
1998		41,880	29,448	302,480
1999		49,598	29,072	327,655
2000		144,481	25,367	405,035
2001		88,462	31,566	325,333
2002		90,479	28,176	203,144
2003		98,265	28,752	90,844
2004		128,397	43,648	121,138
2005		73,904	32,860	176,831
2006	29,086	69,319	35,565	208,269
2007	30,000	103,820	35,303	213,217
Total	59,086	888,605	319,757	2,373,945

