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Fisheries in the Economies

of the Pacific Island Countries and Territories

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Fisheries in the Economies of the Pacific Island Countries and Territories

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Note:
In this paper, "$" refers to US dollars.

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Contents

Abbreviations and Acronyms x
Foreword xiii
About the Author xv
Acknowledgments xvi
Currency Equivalents xviii
Executive Summary xix

Part A. Introduction xxxv

Study Considerations and Definitions 1
Scope 1
Study Area 2
Definitions 4
National Accounts, GDP, and Fishing 6
Structure of the Report 7

Part B. Fishery Benefits in the Independent Pacific Island Countries...... 9

Cook Islands 11
Fish Production 11
Contribution of Fishing to GDP 17
Export of Fishery Products 20
Government Revenue from Fisheries 21
Employment 22
Fish Consumption 24

Federated States of Micronesia **26**
Fish Production 26
Contribution of Fishing to GDP 32
Export of Fishery Products 33
Government Revenue from Fisheries 36
Employment 37
Fish Consumption 38

Fiji Islands **39**
Fish Production 39
Contribution of Fishing to GDP 46
Export of Fishery Products 49
Government Revenue from Fisheries 52
Employment 53
Fish Consumption 56

Kiribati **58**
Fish Production 58
Contribution of Fishing to GDP 65
Export of Fishery Products 68
Government Revenue from Fisheries 68
Employment 70
Fish Consumption 74

Marshall Islands **76**
Fish Production 76
Contribution of Fishing to GDP 83
Export of Fishery Products 85
Government Revenue from Fisheries 88
Employment 89
Fish Consumption 91

Nauru **92**
Fish Production 92
Contribution of Fishing to GDP 97
Export of Fishery Products 99
Government Revenue from Fisheries 99
Employment 101
Fish Consumption 102

Niue **104**
Fish Production 104
Contribution of Fishing to GDP 108
Export of Fishery Products 110

Government Revenue from Fisheries 110
Employment 111
Fish Consumption 113

Palau 114
Fish Production 114
Contribution of Fishing to GDP 121
Export of Fishery Products 123
Government Revenue from Fisheries 124
Employment 125
Fish Consumption 126

Papua New Guinea 127
Fish Production 127
Contribution of Fishing to GDP 135
Export of Fishery Products 137
Government Revenue from Fisheries 140
Employment 141
Fish Consumption 143

Samoa 145
Fish Production 145
Contribution of Fishing to GDP 150
Export of Fishery Products 152
Government Revenue from Fisheries 154
Employment 155
Fish Consumption 157

Solomon Islands 160
Fish Production 160
Contribution of Fishing to GDP 168
Export of Fishery Products 170
Government Revenue from Fisheries 172
Employment 173
Fish Consumption 174

Tonga 175
Fish Production 175
Contribution of Fishing to GDP 180
Export of Fishery Products 183
Government Revenue from Fisheries 185
Employment 187
Fish Consumption 188

Tuvalu **191**
Fish Production........ 191
Contribution of Fishing to GDP........ 196
Export of Fishery Products........ 198
Government Revenue from Fisheries........ 198
Employment........ 200
Fish Consumption........ 202

Vanuatu **203**
Fish Production........ 203
Contribution of Fishing to GDP........ 209
Export of Fishery Products........ 212
Government Revenue from Fisheries........ 213
Employment........ 214
Fish Consumption........ 215

Part C. Fishery Benefits in Pacific Island Territories **217**

American Samoa **219**
Fish Production........ 219
Contribution of Fishing to GDP........ 223
Export of Fishery Products........ 225
Government Revenue from Fisheries........ 226
Employment........ 226
Fish Consumption........ 227

French Polynesia **228**
Fish Production........ 228
Contribution of Fishing to GDP........ 233
Export of Fishery Products........ 237
Government Revenue from Fisheries........ 238
Employment........ 238
Fish Consumption........ 239

Guam **240**
Fish Production........ 240
Contribution of Fishing to GDP........ 244
Export of Fishery Products........ 245
Government Revenue from Fisheries........ 246
Employment........ 246
Fish Consumption........ 247

New Caledonia **248**
Fish Production 248
Contribution of Fishing to GDP 251
Export of Fishery Products 253
Government Revenue from Fisheries 253
Employment 254
Fish Consumption 254

Northern Mariana Islands **255**
Fish Production 256
Contribution of Fishing to GDP 259
Export of Fishery Products 260
Government Revenue from Fisheries 261
Employment 261
Fish Consumption 262

Pitcairn Islands **263**
Fish Production 263
Contribution of Fishing to GDP 266
Export of Fishery Products 267
Government Revenue from Fisheries 267
Employment 268
Fish Consumption 268

Tokelau **269**
Fish Production 269
Contribution of Fishing to GDP 272
Export of Fishery Products 274
Government Revenue from Fisheries 274
Employment 275
Fish Consumption 276

Wallis and Futuna **277**
Fish Production 277
Contribution of Fishing to GDP 280
Export of Fishery Products 281
Government Revenue from Fisheries 282
Employment 282
Fish Consumption 282

International Waters **283**

Part D: Regional Fisheries Production, Benefits, and Factors Influencing Benefits 287

Fisheries and Aquaculture Production Across the Region............. 289
Summary Information...289
General Observations...295
Measuring the Production of Small-Scale Fisheries........................296
Changes in Fishery Production during 1999–2007 297
Aquaculture Production 299

Fishery Benefits Across the Region 305
Contribution of Fishing to GDP in the Pacific Island Countries 305
Exports of Fishery Products..317
Government Revenue from Fisheries..324
Employment Related to Fisheries 333
Fish Consumption 344
Fishery Benefits by Zone 355

Issues in Measuring Benefits.. 358
Household Income and Expenditure Survey..................................358
Satellite Account for Fisheries...363
Subsidies in Fisheries...369

Some Factors that will have Major Impacts on Fisheries Benefits .. 371
Climate Change 371
Fuel Costs 373
Fishery Benefits and Economic Rent 375

Recommendations and Concluding Remarks 377
Recommendations for Improving the Measurement of Fisheries Benefits...377
Concluding Remarks..379

References.. 385

Appendixes 423

Appendix 1: The 2001 Study 425

Appendix 2: National Accounting and the Fisheries Sector 435
Definitions and Conventions in the System of National Accounts..435
Weaknesses of GDP 440

Appendix 3: Guidelines for Calculating the Fishing Contribution to GDP 442
General 442
Value-Added Ratios 444

Appendix 4: Preliminary Assessment of the Effects of Climate Change on Fisheries and Aquaculture in the Pacific 451
Introduction 452
Changing Climate and Ocean 452
Effects of Climate Change on Fisheries Worldwide 455
Potential Impact of Climate Change on Fisheries and Aquaculture in the Pacific 458
Adaptations to Maintain the Benefits of Fisheries and Aquaculture 466
Gaps in Knowledge and Priority Activities 468

Appendix 5: The Energy Costs and Fishing Study 470
Fuel Supply Markets 470
Exposure to Fuel Price Fluctuations 473
Operational Changes as a Result of Increased Fuel Costs 477
Market Changes 477
Reduction of Exposure to Fuel Price Fluctuations 478
Recommendations 480

Abbreviations and Acronyms

ADB	Asian Development Bank
ADO	automotive diesel oil
AusAID	Australian Agency for International Development
BMR	Bureau of Marine Resources (of Palau)
CBSI	Central Bank of the Solomon Islands
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CNMI	Commonwealth of the Northern Mariana Islands
CO_2	carbon dioxide
COFISH	Pacific Regional Coastal Fisheries Development Programme
DEVFISH	Development of Tuna Fisheries in the Pacific ACP Countries
DFMR	Department of Fisheries and Marine Resources
DOF	Department of Fisheries
EEZ	exclusive economic zone
ENSO	El Niño–Southern Oscillation
FAD	fish aggregation device

FAO	Food and Agriculture Organization of the United Nations
FFA	Forum Fisheries Agency
FOB	free on board
FSM	Federated States of Micronesia
GDP	gross domestic product
HIES	household income and expenditure survey
IMF	International Monetary Fund
ISIC	International Standard Industrial Classification of All Economic Activities
ISPF	Institut de la Statistique de la Polynesie Francaise
JICA	Japan International Cooperation Agency
MIMRA	Marshall Islands Marine Resources Authority
NFA	National Fisheries Authority (of Papua New Guinea)
NFMRA	Nauru Fisheries and Marine Resources Authority
NMFS	National Marine Fisheries Service (of the United States)
NORMA	National Oceanic Resource Management Authority (of FSM)
NSO	National Statistics Office
OFCF	Overseas Fishery Cooperation Foundation (of Japan)
PCS	Palau Conservation Society
PICTs	Pacific Island Countries and Territories
PMDC	Palau Mariculture Demonstration Center
PNG	Papua New Guinea
RMI	Republic of the Marshall Islands
SNA	System of National Accounts
SPC	Secretariat of the Pacific Community (formerly, South Pacific Commission)
t	ton (metric)

UNDP	United Nations Development Programme
US	United States
VAR	value-added ratio
WCPFC	Western and Central Pacific Fisheries Commission
WCPO	Western and Central Pacific Ocean
WPacFIN	Western Pacific Fisheries Information Network

Foreword

In early 2001, the Asian Development Bank (ADB) expressed concern that the importance of fisheries to Pacific Island economies was not being fully appreciated by the countries of the region or by the donor community. Discussions with Forum Fisheries Agency (FFA), the Secretariat of the Pacific Community (SPC), and the World Bank led to a study to improve the accuracy of the estimates of the contribution of fisheries to national economies. The output of that study was the publication *The Contribution of Fisheries to the Economies of Pacific Island Countries.*

That report identified the official contribution of fishing to gross domestic product (GDP), articulated a simple approach for estimating fishing contribution to GDP, and reestimating fishing contribution to GDP for each Pacific island country. It showed the major reasons for differences between the official and reestimated contribution of fishing to GDP and discussed the common difficulties found in estimating the contribution. It also made estimates of quantities and values of production from the four major components of fishing in the region: coastal commercial, coastal subsistence, offshore locally based, and offshore foreign-based. Finally, it provided summaries of the available data on fishery aspects of employment, trade, government revenue, and nutrition.

Since the report was published, several significant changes have occurred in the fisheries sector of the Pacific islands concerning the fishery resources; fishing practices; and national, regional, and international policies.

In 2007, the Australian Agency for International Development (AusAID) produced a framework for engagement in fisheries-related development assistance in the Pacific, which called for the development of regularly updated and disaggregated information on the contribution of subsistence, small-scale, commercial, and industrial fisheries to the economies of Pacific island countries. AusAID and ADB subsequently agreed to update the 2001 publication.

Discussions between AusAID, ADB, FFA, SPC, and the World Bank (project partners) resulted in an understanding that the new study should be similar in scope to the 2001 project. Major changes for the new study were the inclusion of

- nonindependent Pacific island territories;
- production from freshwater fisheries and aquaculture;
- fishery production from high seas areas in the Central and Western Pacific;
- gender aspects of fisheries employment;
- benefits partitioned by zone: inland, inshore, coastal, and offshore; and
- specialized studies of factors that could have significant impacts on the benefits that flow from fisheries in the region (i.e., fuel costs, climate change).

ADB recruited a consultant for the project—Robert Gillett, who led the 2001 study—and work began on 1 August 2008. Visits to collect information were made to most Pacific island countries and/or territories and headquarters of the regional organizations in August to October. A meeting of all project partners was held in late September. Country-specific information was assembled, analyzed, and passed to fisheries and statistics experts in each country for comment. During September to December 2008, two consultants, recruited by the World Bank and ADB, studied the impact of fuel costs on benefits from fisheries. In mid-January 2009, an SPC officer summarized for the study the likely impacts of climate change on fisheries in the Pacific islands.

This new publication brings much new information and advice on a wide variety of fisheries-related matters that will be of great use among the independent and nonindependent economies of the Pacific region. I am confident that it will be an important reference document for several years.

However, the present study was also intended to provide the basis for progressive refinement and development of a regular assessment of the region's fisheries, which ideally would be done every 4–5 years. I urge that national and regional agencies involved with fisheries and their development partners consider ways of institutionalizing the collection and dissemination of economic information on fisheries in order to give the fisheries sector the priority it deserves.

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About the Author

Robert Gillett, a director of Gillett, Preston and Associates (gillett@connect.com.fj) has been involved in marine resources development in the Pacific islands for the past four decades. He has undertaken work for several regional and international organizations active in the marine sector in the region, including United Nations Development Programme, Secretariat of the Pacific Community, Forum Fisheries Agency, Food and Agriculture Organization of the United Nations, World Bank, Secretariat of the Pacific Regional Environment Programme, University of the South Pacific, Pacific Islands Forum Secretariat, Commonwealth Secretariat, and Asian Development Bank. Mr. Gillett has authored over 250 publications, books, and technical reports on fisheries in the region.

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Many people contributed to this study. The project partners consisted of people in five institutions that participated in formulating the project, were involved in its implementation, and provided technical guidance. The agencies and associated staff were the Asian Development Bank (Thomas Gloerfelt-Tarp), Australian Agency for International Development (Gordon Anderson), World Bank (Oliver Braedt and Gert van Santen), Secretariat of the Pacific Community (Lindsay Chapman, Johann Bell), and the Forum Fisheries Agency (Peter Philipson and Len Rodwell). In addition, the Directors-General of the Forum Fisheries Agency and Secretariat of the Pacific Community (SPC), Su'a N.F. Tanielu and Jimmie Rodgers, provided endorsement and enthusiastic support for the work.

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The advice provided by Les Clark in the 2001 study is still quite evident in the present report.

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The maps in this report were kindly provided by SPC.

Currency Equivalents

The average yearly exchange rates for the US dollar used in this report are shown below. Countries and territories not shown use the US$.

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
New Zealand dollar (Cook Islands, Niue, Pitcairn Islands, Tokelau)	1.86	1.89	2.19	2.38	2.15	1.72	1.51	1.42	1.54	1.36	1.32
Fiji dollar (Fiji Islands)	2.00	1.98	2.13	2.33	2.15	1.85	1.73	1.70	1.73	1.60	1.51
Pacific franc (French Polynesia, New Caledonia, Wallis and Futuna)	107.00	112.00	130.00	133.00	127.00	106.00	96.00	96.00	95.00	87.00	80.00
Australian dollar (Kiribati, Nauru, Tuvalu)	1.59	1.55	1.74	1.95	1.83	1.52	1.36	1.31	1.32	1.19	1.10
kina (Papua New Guinea)	2.06	2.55	2.76	3.36	3.89	3.55	3.22	3.10	3.06	2.96	2.77
tala (Samoa)	2.94	3.01	3.27	3.47	3.37	3.00	2.78	2.71	2.78	2.62	2.52
Solomon Islands dollar (Solomon Islands)	4.82	4.84	5.09	5.28	6.75	7.51	7.48	7.53	7.61	7.65	7.67
pa'anga (Tonga)	1.35	1.58	1.64	1.95	2.18	2.19	2.04	1.93	2.01	2.02	1.85
vatu (Vanuatu)	127.52	129.08	137.80	145.70	139.10	122.20	111.90	109.00	110.00	104.00	96.77

Source: ADB Subregional Office, Suva, the Fiji Islands (T. Gloerfelt-Tarp, personal communication, December 2008).

Executive Summary

This report updates and expands on the 2001 report on *The Contribution of Fisheries to the Economies of Pacific Island Countries*. The focus of that publication was the contribution of fishing to gross domestic product (GDP) and it provided an independent estimate of that contribution. In the present report, the scope is expanded to include Pacific Island territories, aquaculture and freshwater fisheries, and some important factors likely to affect the flow of benefits from fisheries in the future.

Information on benefits from fisheries is provided for each of the 22 Pacific island countries and territories in terms of (i) recent annual production and value for six categories—coastal commercial fishing, coastal subsistence fishing, locally based offshore fishing, foreign-based offshore fishing, freshwater fishing, and aquaculture; (ii) official and reestimated contribution to GDP and exports; (iii) government revenue; (iv) employment; and (v) contribution to nutrition. Where data were available, comparisons are made between the situation in 1999 and 2007, the focus years of the 2001 study and the present study, respectively.

Regional Fisheries and Aquaculture Production

Total fisheries and aquaculture production in the region in 2007 is estimated to be 1,330,345 tons (t), plus 305,336 items ("pieces") of aquaculture products (i.e., pearls and aquarium items not usually sold by weight) (Table 1). Ranking of countries by total fisheries production was strongly influenced by the level of tuna catches. Also, there was a general pattern of decreasing total national catches from west to east across the region, and from equatorial to higher latitudes.

Table 1: Total Regional Fishery and Aquaculture Production, 2007 (t)

Item	Coastal Commercial	Coastal Subsistence	Offshore		Freshwater	Aquaculture	Regional Total
			Offshore Locally Based	Offshore Foreign-Based			
Fishery category totals	44,789	109,933	401,096	864,685	23,858	2,984 t and 305,336 pieces	1,447,345 t and 305,336 pieces
Totals adjusted for duplicate offshore fishing	44,789	109,933	1,148,781		23,858	2,984 t and 305,336 pieces	1,330,345 t and 305,336 pieces

t = ton.

Source: Author's estimates.

Other significant features were a relatively large contribution of offshore foreign-based production in Kiribati, Federated States of Micronesia, Solomon Islands, Nauru, and Tuvalu; relatively large contribution of offshore locally based production in the Marshall Islands and (to a lesser extent) the Fiji Islands; relatively large contribution of aquaculture production in French Polynesia and (to a lesser extent) New Caledonia; and relatively large contribution of non-tuna production in Fiji Islands.

Catches in the seven international sea areas in the Western and Central Pacific Ocean (WCPO) region during 2002–2007 were equal to about half (range 38%–59%) of all in-zone catches of the 22 countries and territories of the Pacific islands. The total catch in 2007 from international waters was about 21% of the catch taken from the entire WCPO, including the WCPO catch of Indonesia, Japan, Philippines, and Taipei,China. Of the 2007 catch, 17% of the total catch and 37% of the total value were made by longliners; 60% and 42%, respectively, by purse seiners; and 23% and 22%, respectively, by pole-and-line vessels.

For the 14 independent countries in the region, the 2007 information can be compared with the situation in 1999. A look at the changes in fishery production shows a remarkable increase by Papua New Guinea (PNG) and moderate increase by most other countries. By fishing category, substantial production increases were noted in offshore fisheries while coastal fishery production showed no overall change.

The stagnation of coastal fishery production means that a certain level of food and employment has to be spread among a growing number of people. With the generally expanding offshore fisheries, the distribution of benefits from fisheries sector in the Pacific islands is already undergoing a profound change. Benefits from employment and nutrition—things that directly affect Pacific islanders, and which disproportionately come from the coastal zone—are stagnating. The less tangible and more abstract benefits (contribution to GDP, exports, and government revenue) tend to come disproportionately from the offshore area, and are expanding.

However, estimating the production from coastal fisheries in about half the Pacific island countries is largely guesswork. In very few of them, the levels of coastal catches are well known. This is likely to be a factor in the under appreciation for these fisheries in many countries. Poor data on coastal fisheries production creates considerable difficulty in accurately portraying fishery benefits, especially in GDP contribution, employment, and nutrition. Protection of village food fish supplies is arguably the most important objective of the management of coastal fisheries in the Pacific islands, but to know if such management efforts are effective overall, some idea of the gross coastal fisheries production is required. In terms of government priorities, it seems that a lack of production information tends to lead to lack of attention.

Aquaculture in the region is strongly dominated by pearl production in French Polynesia and shrimp farming in New Caledonia, but both territories have a high degree of economic support from France and have large subsidies for aquaculture. PNG is also a special case due to its relatively huge population and because over 87% of the population live inland and have no direct access to marine resources. If aquaculture production from these three atypical countries is eliminated from consideration, significant aquaculture production comes from a limited range of activities, most notably large-scale private sector pearl culture and shrimp culture where there is a significant tourist trade. There is substantial tilapia and/or milkfish and giant clam culture, but net benefits depend on the degree of subsidization—a situation that is often not clear.

Regional Fisheries and Aquaculture Value

The total value of fisheries and aquaculture production in 2007 is estimated to be over $2 billion (Table 2). Offshore foreign-based fishing accounted for about half the value of fisheries in the region, offshore locally based accounted for about a quarter, and the remaining quarter was shared almost equally by coastal commercial, coastal subsistence, and aquaculture. French Polynesia and New Caledonia produced 95.5% of the combined value of aquaculture in all the 22 Pacific island countries and territories.

Table 2: Value of Total Regional Fishery and Aquaculture Production, 2007 ($)

Item	Coastal Commercial	Coastal Subsistence	Offshore		Fresh-water	Aqua-culture	Regional Total
			Offshore Locally Based	Offshore Foreign-Based			
Fishery category totals	165,691,002	200,366,961	596,836,589	1,086,581,587	23,115,025	146,872,423	
Totals adjusted for duplicate offshore fishing	165,691,002	200,366,961	1,513,418,176		23,115,025	146,872,423	2,049,463,587

Note: Table includes aquaculture. Values are dockside, at first sale, or farm gate.

Source: Author's estimates.

The estimated total value of the six fishing categories in each country and territory is shown in Table 3. The four countries with the highest value produced almost 72% of the regional total; the eight highest producers contributed 95%.

Table 3: Value of Fisheries and Aquaculture Production by Country and/or Territory, 2007

Country and/or Territory	Value ($)
Papua New Guinea	812,067,902
Kiribati	244,185,828
Federated States of Micronesia	224,483,967
Solomon Islands	202,003,233
French Polynesia	188,656,724
Marshall Islands	108,125,102
Fiji Islands	103,420,625
Nauru	81,518,168
New Caledonia	49,663,126
Tuvalu	43,773,582
Samoa	42,939,982
Vanuatu	34,397,887

continued on next page

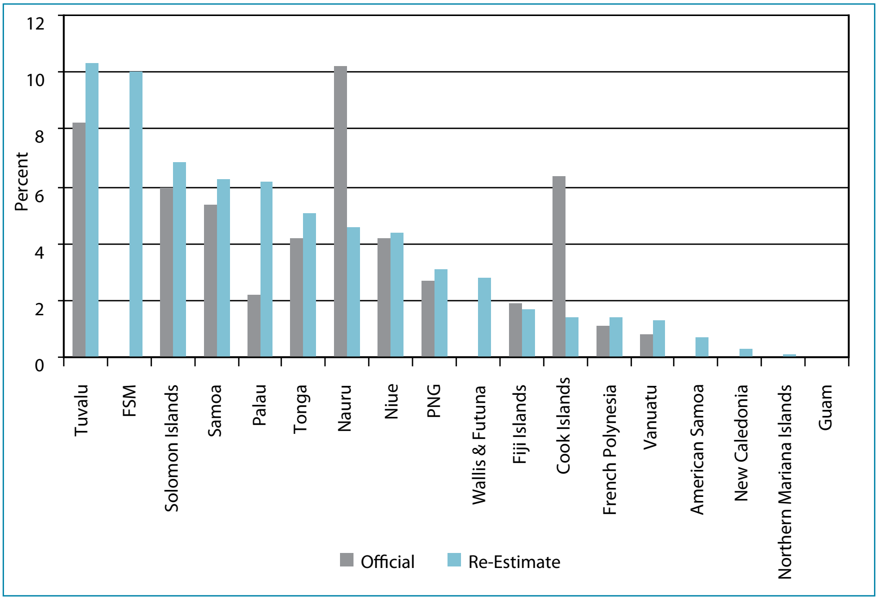
Table 3: continuation

Country and/or Territory	Value ($)
Palau	24,139,152
Tonga	20,571,101
American Samoa	14,793,083
Cook Islands	10,323,529
Wallis and Futuna	7,540,230
Niue	2,520,588
Northern Mariana Islands	1,786,700
Guam	1,370,000
Tokelau	1,108,812
Pitcairn Islands	74,265

Note: Values are dockside, at first sale, or farm gate.

Source: Author's estimates.

Figure 1: Official and Reestimated Fishing Contribution to GDP, 2007



FSM = Federated States of Micronesia, PNG = Papua New Guinea.

Source: Author's estimates.

Contribution to Gross Domestic Product

The official fishing contributions to GDP in 2007 were compared with reestimates of that contribution based on revised production estimates determined in this study. The data are summarized in Figure 1. In most cases, the reestimate was larger than the official figure. In two (Cook Islands and Nauru), the reestimate was substantially smaller. Based on good knowledge of the fishing sector, the official results in those two countries are likely to be erroneous.

Increases in fishing contributions to GDP from 1999 to 2007 were greatest in the Marshall Islands (with the establishment of a locally based offshore fleet) and PNG (with increased activity of the locally based offshore fleet). There were pronounced decreases in the Cook Islands (with the decrease in production from pearl farming) and Nauru (with the termination of locally based offshore fishing and a decrease in coastal commercial fishing). At least some of the observed changes were due to improved estimates of various categories of fishing.

An important point is that, for national accounting purposes, the sector is "fishing," rather than the more inclusive "fisheries." Postharvest activities, including fish processing, are not included in the fishing sector when estimating GDP. To compensate for this, a crude "satellite account" to include these subsectors was made for the Fiji Islands, which showed that the fisheries sector contributed 34% more to GDP in 2003 than the fishing sector. Based on the Fiji Island's total GDP in 2003 of F$4.4 billion, the contribution to GDP increased from 1.8% for the fishing sector to 2.3% for the fisheries sector.

Simple and obvious ways are available to improve the accuracy of estimating fishing contribution to GDP. The most important are that statistics staff should (i) obtain technical fisheries expertise when devising methodology, collecting data, making the estimate, and reviewing the results; and (ii) compare the official estimate to the reestimate of the fishing contribution given in the country chapters of this report and evaluate the differences and any need for modifying the methodology.

Fishery Product Exports

Exports of fisheries products are very important to the countries of the region (Table 4). In about half of these countries, these exports represent over half of all exports. In six Pacific island countries and territories, the export value of fishery products is about 80% or greater of total exports.

Where they represent less than half of the value of national exports, exports are mostly quite large in nominal terms, as in New Caledonia

($157 million), PNG ($101 million), Fiji Islands ($63 million), and Marshall Islands ($37 million). The three with the largest value of exports are American Samoa, New Caledonia, and French Polynesia. Of the total $996 million in fishery exports in the region in 2007, about three-quarters are from these three territories.

By far the most important exports in value are tuna products. Tuna exports from American Samoa alone are close to the value of *all* the other fishery exports in *all* other Pacific island countries combined.

In nominal terms, the value of fishery exports of the region almost doubled during 1999–2007. Fishery exports have increased relative to total exports in most countries, but have fallen significantly in the Solomon Islands and Samoa.

Table 4: Value of Fishery Product Exports ($)

Country	1999	2007
Papua New Guinea	48,106,666	101,000,000
Fiji Islands	29,193,745	63,217,953
Marshall Islands (2006)	473,000	37,342,000
Solomon Islands	35,472,033	19,784,631
Palau	2,213,419	19,000,000
Federated States of Micronesia	4,878,387	12,301,318
Samoa	10,785,287	7,634,000
Tonga (FY 2007)	2,573,670	4,861,780
Cook Islands	2,919,136	4,120,828
Kiribati	1,483,871	1,893,375
Vanuatu (average for 2004–2007)	394,954	1,230,189
Tuvalu	4,233	4,216
Nauru	0	0
American Samoa (2006)		438,529,360
French Polynesia		128,379,310
New Caledonia		156,908,046
Wallis and Futuna		78,161
Pitcairn Islands		37,542
Northern Mariana Islands		0
Guam		n/a
Tokelau		n/a

FY = fiscal year, n/a = not available.

Note: Data are for 2007, unless otherwise noted; prices are free on board (FOB).

Source: Author's estimates.

Interestingly, several countries located in areas of good tuna fishing (as judged by access fees) export little or no tuna, such as Kiribati, Nauru, Tokelau, and Tuvalu. If they were included, the data would better reflect the potential importance of foreign fisheries production for the local economy. In addition, in most countries, the official value of fishery exports is underestimated compared to other sources of similar information (e.g., importing country information, Convention on International Trade in Endangered Species [CITES] records, and audited exporting company accounts). This could be due to the complexity of tracking a multitude of different fisheries products each with different values, large numbers of small shipments, and many different export points. Often, there is no examination by customs departments of the exported commodities. Also, some countries record as nonfishery commodities some products that would often be considered fisheries products, such as coral.

Foreign Fishing Access Fees

Access fees received by Pacific island countries are provided and compared to total government revenue, population, and catch value. Total access fees received in 2007 were $78.5 million, an increase of about 25% since 1999. For the independent countries covered in both studies, access fees increased in nominal terms for all but three countries, with an overall increase of almost $18.7 million. Access fees fluctuate widely from year to year because of changing fishing patterns, fleet movements, and exchange rates. On a per capita basis, fees in 2007 ranged widely, from less than $1 per person in the Fiji Islands to $1,264 in Tokelau. Fees also varied widely in terms of their proportion of the catch value of the foreign fleets, mainly due to varying levels of fishing; sometimes there was no fishing in a zone although access fees were paid.

For the independent countries covered in both studies, access fees increased in nominal terms for all but three countries, with an overall increase of almost one-quarter ($18.7 million) in the 7 years between the estimates, although it should be noted that access fees can fluctuate widely from year to year because of many factors (e.g., fleet movements, exchange rates).

Information on access fee receipts was available in the public domain for most countries. Where this was not the situation, fisheries and/or finance officials cooperated to furnish the information. This favorable change appears to be in accordance with the "Vava'u Declaration on Pacific Fisheries Resources" issued at the Thirty-Eighth Pacific Islands Forum held in October 2007, which stressed the importance of transparency in fisheries licensing arrangements. In the 2001 study, considerable secrecy was encountered surrounding access fee payments, even at the aggregate national level, and much of the data on access fee payments in that study were estimated with considerable difficulty.

Fisheries Employment

For each country of the region, the best readily available information is provided on the relative importance of (i) employment in commercial fisheries, and (ii) involvement in subsistence fishing. Most formal employment in fisheries appears to be tuna-related. Participation in mixed subsistence and/or commercial fishing is significant in survey results from Nauru, Niue, Tuvalu, and Vanuatu, but is likely to be important in several other countries also. Regionwide, involvement in subsistence fishing is vastly greater than formal fisheries employment. Typically, 10–20 times more people fish for subsistence than for commercial purposes.

Two important features of the data are presented. One, the importance of participation in subsistence fisheries seems to have a strong relationship with the type of island. For example, in the Cook Islands, 92% of people engage in fishing in Mangaia Island, one of the outer islands, while on the main island, Rarotonga, less than half of all households (44%) fish. In general, the level of importance is highest in atolls, followed by small islands, and least in large high islands. Two, the importance of fisheries in formal employment seems to be related more to business conditions than to island type. These conditions include, among others, the proximity to processing facilities and airline connections to fresh fish markets.

PNG stands out in participation in coastal subsistence fisheries, with one often-quoted study estimating "between 250,000 and 500,000" such fishers. These numbers approach the magnitude of the participation in *all* the other countries of the region combined.

Information on fisheries employment is critically important not only for estimating the benefits to the countries concerned but also for fisheries management. In the many trade-offs that fisheries management entails, it is important to know how many people will be affected—positively or negatively—by management decisions. With the possible exception of employment related to tuna (fishing and/or processing), few data are available for employment by fishery in any of the countries of the region.

The message is that the availability of fisheries employment information by fishery could improve fisheries management decisions. Other disaggregations that would be useful to fisheries management are by sex, by urban and/or rural resident, and by local and/or expatriate. A ban on relatively high technology (e.g., use of scuba gear) would favor rural fishers. The use of Asian versus local crews on locally based tuna vessels is a topical fisheries management issue in several countries of the region.

Participation of Women

Due to national and regional efforts over the past 15 years, much more is now known about women's fisheries activities in the Pacific islands. Presently, the main difficulties that affect the accurate portrayal of the importance of women in fisheries employment appears to be (i) the concept of using "main unpaid activity" in surveys for defining the subsistence fisheries sector, as it downplays the importance of secondary activities (e.g., even for women who do considerable fishing, childcare is often the main unpaid activity); and (ii) placing commercial fish processing in some countries (where many women are employed) in the manufacturing sector.

A survey in 2008 of villages in 17 countries or island groups by the Secretariat of the Pacific Community showed a general dominance of fishing at the village level by men, although the proportions differed by country from about 80% males in French Polynesia, Federated States of Micronesia, Samoa, and Tuvalu, to nearly equal numbers of males and females in the Fiji Islands, PNG, Wallis and Futuna, and Vanuatu. Invertebrate harvesting (such as through reef gleaning), is still the women's domain.

Fish Consumption

For most countries, there have not been any dedicated national level studies of fish consumption in the last decade. Ranges in national fish consumption as determined by various studies in the 1990s are shown in Table 5.

In general, countries comprising small islands have high fish consumption rates, while large island countries have low consumption rates. The exceptions to this are Tonga, where the studies suggest surprisingly low fish consumption rates, and Palau, where reported fish consumption rate is remarkably high. Most Pacific island countries exceed—by a large margin—the world average per capita fishery product consumption rate of 16.5 kg. Based on the predicted age structure of populations in the Pacific until 2030 and age–weight relationships, an annual average per capita fish consumption of 34–37 kg is estimated to provide about 50% of the recommended protein intake for people in the Pacific island countries.

Table 5: Ranges of Estimated Annual Per Capita Fishery Product Consumption

Country	Range of Estimates (kg/year/person)
Cook Islands	47.0–71.0
Federated States of Micronesia	72.0–114.0
Fiji Islands	44.0–62.0
Kiribati	72.0–207.0
Marshall Islands	38.9–59.0
Nauru	46.7
Niue	49.0–118.9
Palau	84.0–135.0
Papua New Guinea	18.2–24.9
Samoa	46.3–71.0
Solomon Islands	32.2–32.7
Tonga	25.2–30.0
Tuvalu	85.0–146.0
Vanuatu	15.9–25.7

kg = kilogram.

Note: Estimates are on whole fish equivalent basis.

Source: Author's estimates.

Some of the past comparisons between fish consumption surveys and between countries may be inappropriate due to methodological differences. The main difficulty is that most studies on fish consumption in the region determine one of two kinds of consumption: either the amount of food actually ingested or the whole weight of the fish that produces the food. Comparing fish consumption surveys should be avoided unless the methods used by the studies are known and they are either the same or corrected so that equal features are being compared.

In recent years, most Pacific island countries have had a household income and expenditure survey (HIES). All of the independent Pacific island countries and several of the territories are planning for the HIES in the next few years. The HIES may be a good opportunity to improve the measurement of small-scale fisheries. Indeed, the HIES may not just be an option for obtaining information on small-scale fisheries; an improved HIES may represent the *only* cost-effective mechanism for obtaining information on small-scale fisheries.

Some significant problems, however, are apparent in the present use of HIES for fishery purposes. A feature common to many countries of the region is that coastal fisheries production estimated by the HIES appears to be relatively low. The HIES generally suggests fish catches significantly smaller than that estimated by other survey techniques or smaller than that perceived by specialists familiar with national fisheries. For example, in the eight countries in the present study from which fisheries production levels could be obtained from both the HIES and a more fisheries-focused estimate, the HIES indicated or suggested a lower production in six countries, similar production in one country (Cook Islands), and higher production in another country (Samoa).

Effects of Climate Change

Alterations in ocean temperatures and currents and the food chains in the open ocean are projected to affect the future location and abundance of tuna species in the Pacific islands. Initial modeling indicates that the concentrations of skipjack and bigeye tuna are likely to be located further to the east than in the past. The simulations have yet to be done for yellowfin and albacore.

Significant changes to the future distribution of tuna will make the zones of some Pacific island countries more, or less, favorable for the surface fishery for skipjack tuna. Displacement of tuna stocks further east in the Pacific would be a windfall for the countries in those areas. Reduced abundance of skipjack in Melanesia should have a far lower impact on their GDP in relative terms, but there will be substantial losses in real terms given the large quantities of tuna currently caught there. There may be negative effects on the viability of canneries in the western Pacific.

Significant changes can also be expected in the availability and relative abundance of (i) fish and invertebrates, including such export products as trochus and *bêche de mer*, that currently support coastal fisheries in the Pacific—due to degradation of coral reefs and seawater conditions from increasing temperature and gradual acidification of the ocean; and (ii) other habitats, such as mangroves and seagrass—due to increases in temperatures, sea level, storm intensity, and turbidity of coastal waters because of higher rainfall.

Since coastal fisheries are vital to subsistence throughout the Pacific, one of the greatest impacts that climate change is likely to have is on food security. If future production of fish from coral reefs and the other coastal habitats decreases, or is comprised of fish not readily accepted as food by local communities, the emerging gap in the fish needed for food security will increase. This will place even more pressure on governments to allocate an increasing proportion of their tuna resources for local food security.

Impact of Fuel Costs

Fuel price impact on fishing has fluctuated considerably among fisheries and countries. While the largest component of domestic fuel price—the international bulk price—has risen and declined dramatically over the past 10 years, very significant variations in fuel prices occur between countries, the lowest price being in French Polynesia ($0.56/liter) and the highest in Vanuatu ($1.87/liter).

Of the main categories of fishing gear used in the region, tuna longliners have the highest fuel consumption per ton of catch—on average, over 4 times as much as purse seiners. Small-scale coastal fisheries fall between the two, consuming about twice as much fuel per ton as purse seiners. The costs of fuel per dollar of catch value show similar differences, but less pronounced, because prices of some fish products have increased more than others.

The financial impact of fuel price increases of longliners is still greater than that of purse seiners but the difference is very much smaller than that in specific fuel consumption per ton of catch, because of increases in fish prices. Artisanal fishers are the most financially exposed of all the fleets analyzed.

The exposure of aquaculture to energy cost fluctuations varies substantially: pearl aquaculture is estimated to consume only about $3 per $100 of product value, and intensive penaeid shrimp aquaculture is estimated to consume 1.7 t of fuel per ton of product, but if feed production were to be taken in to account, its fuel consumption would be higher.

Changes in operations as a result of increasing fuel costs in the offshore purse seine sector have been virtually zero; increased technical efficacy and favorable prices for skipjack and yellowfin tuna offset increased fuel costs. For domestic-based longliners that faced increases in fuel prices without product price increases while experiencing drops in catch per unit of effort, modest operational changes were made. Many small-scale fisheries facing higher fuel costs reduced the distance traveled and changed gear.

Satellite Accounts

An example of a satellite account for Fiji Islands fisheries that included postharvest activities indicates that the importance of fisheries in most Pacific countries and territories is being underestimated. By international convention, the "fishing" sector for GDP purposes does not include postharvest activities, which are quite important in many Pacific island countries—and are likely to become more important in the future. Preparation and publicizing of such accounts would elevate fisheries in national agenda.

Satellite accounts would be most useful in countries where there is a sizeable fisheries industry, development plans that could affect the industry, and various industrial sectors competing for government attention. In this regard, a satellite account would be an important tool for industry "champions," individuals who are influential in stressing the importance of the sector. At present, the fisheries sector is not active in most countries at advertising its importance. Several comparisons are made with the tourism sector, where it was noted that, for example, a huge benefit like that from transshipping fish would be publicized in the tourism sector with enthusiasm.

Fishery Benefits and Economic Rent

A recent study provided a theoretical assessment of the potential regional economic wealth of tuna resources and the relative drain of economic rent—the difference between total revenue in the fishery and the fishery costs—resulting from the current fisheries governance model. The study estimated that future governance based on a business-as-usual approach over a period of 50 years would generate economic losses in net present value terms of at least $3.4 billion compared to optimal harvesting. This is despite the fact that, overall, the fisheries currently generate positive profits.

Main Conclusions and Recommendations

Fisheries are Important in the Region. In 2007, the fishing sector in the region contributed up to 10% of GDP—but these contributions excluded postharvest activities. Fishing sector GDP estimates for countries, with fish processing and transshipment activities, are likely to substantially underestimate the economic importance of the broader fisheries sector. Contributions of the fishing sector to GDP between 1999 and 2007 increased due to both higher fish production and landed value of the catch.

Coastal Resources: Reaching the Limits. Stagnation of coastal fisheries production in most countries of the region has major implications for local income and nutrition levels, as well as for government fisheries agencies—

many of which are oriented to developing coastal fishery potential. The situation may require their fundamental reorientation to include a strong emphasis on safeguarding the existing food and jobs from the coastal zone. Determining production levels of coastal fisheries deserves more attention because these fisheries have the greatest direct effect on the lives of Pacific islanders. A promising way that would serve several purposes is to improve the conduct of HIES through cooperation of fisheries and HIES specialists in an initiative to improve the applicability of HIES to the fisheries sector.

Subsidies: Hidden Costs of Benefits. As noted, fisheries-related subsidies in the region, while not necessarily all bad, suffer from lack of transparency and lack of an exit strategy. Discussions of subsidies are not common in the fisheries and aquaculture literature of the region. Further investigation could result in any subsidies being more effectively applied, or alternatively, it could point to more effective uses of public funds. Schemes that subsidize various aspects of fisheries should be regularly analyzed by individuals external to the subsidy program to determine if the objectives of the subsidy are being achieved, if there is a favorable cost–benefit ratio of the subsidy, and if alternative mechanisms could be more appropriate or effective than the subsidy.

Improving Management. Given the huge economic gains that can be made through improved management of tuna fisheries, changes in tuna fisheries management should be considered. The specific nature of these changes should be the subject of future studies.

Reducing Fuel Costs. Fuel price fluctuations in recent years have affected domestic coastal fisheries. Policy options that combine technical measures with efforts to improve competitive and efficient sourcing of fuel could be considered. Temporary adjustments of taxation and excise on fuel could also be considered.

Aquaculture: Improving the Track Record. The contribution of aquaculture to the economies of the region, although presently small, could be increased. Suggestions to improve both national and regional aquaculture potential are (i) to regularly evaluate the effectiveness of the development models being pursued, especially if the model has resulted in limited success over many years; and (ii) to analyze periodically the net benefits and potential of aquaculture development initiatives.

Economic Analysis: Ensuring Objectivity. The economic analysis of benefits from the fisheries sector should ensure that the analytical work on specific subsectors is completely independent of individuals involved in promoting that subsector. An independent analysis of subsidies, as discussed earlier, is also important.

Promoting the Fisheries Sector: Where Are the Champions? Measuring the fisheries contribution to the economies of Pacific island countries could be improved markedly by closer liaison between fisheries and statistics agencies. The fisheries agencies are in a position to provide information on new developments, technical insights, and recent data—all of which could improve the measurement of fisheries benefits. This cooperation, however, rarely occurs in the Pacific island countries. Because fisheries agencies have a vested interest in assuring that the importance of their sector is not underestimated, they should take the lead in improving this cooperation. The sector is also underemphasized in the region at present, despite its critical importance in many Pacific islands. Influential persons to act as "champions" should be encouraged to publicize the value of a country's fisheries; a satellite account would be an invaluable tool in such an effort.

PART A

Introduction

Study Considerations and Definitions

Scope

This study updates and expands on the 2001 study on *The Contribution of Fisheries to the Economies of Pacific Island Countries*. The focus of that study was the contribution of fishing to gross domestic product (GDP). It provided an independent estimate of that contribution. In the present study, the scope is expanded to include Pacific island territories, aquaculture, and freshwater fisheries, and some important factors likely to affect the flow of benefits from fisheries in the future.

Included are (i) country information on specific topics (fisheries production, contribution to GDP, and others), (ii) a discussion of important regional topics (e.g., the regional significance of access and exports of fishery products), (iii) some important features of the benefits from fisheries that have emerged from this study, and (iv) major factors that influence the flow of benefits from fisheries.

An important difference between this present publication and the 2001 report concerns prices. In this report, except where otherwise noted, fish prices given are the prices paid to the producer—either dockside prices, prices at first sale, or (for aquaculture and subsistence fishing) farm-gate prices. For offshore fishing, an analogous system is used in which the readily available world market prices for the concerned fishery commodities are discounted by an amount to cover transport of the commodities to those markets. In other words, it uses a pricing system that closely reflects the in-zone value—an important consideration in periods of high fuel costs.

In most cases, prices for the production from offshore fishing are based on those given in a study by the Forum Fisheries Agency (FFA) (FFA 2008). Where information judged to be more accurate is available (i.e., data from the American and French territories), the more precise source is used. Unless otherwise stated, all GDP values are expressed in current market prices.

The valuing of subsistence fisheries production requires special attention. Several methods could be used to assign a monetary value to subsistence production, including (i) farm-gate pricing (used in this report), (ii) value of calories produced, (iii) opportunity cost of labor, or (iv) reservation price of labor. Farm-gate pricing uses the market price of the product less the cost of getting that product to market. This means that the value of own consumption is equivalent to the price the product could be sold for in the market, less the cost of getting the product to market. The approach assumes that the amount of subsistence production would have little or no effect on the market price if it were to be marketed. While each of these valuation methods has its advantages and disadvantages, there are practical issues that determine which method is best used. In this report, the farm-gate pricing method was used, as recommended by the Secretariat of the Pacific Community (SPC) in the publication, *A Guide to Estimating the Value of Household Non-Market Production in the Pacific Island Developing Countries* (Bain 1996).

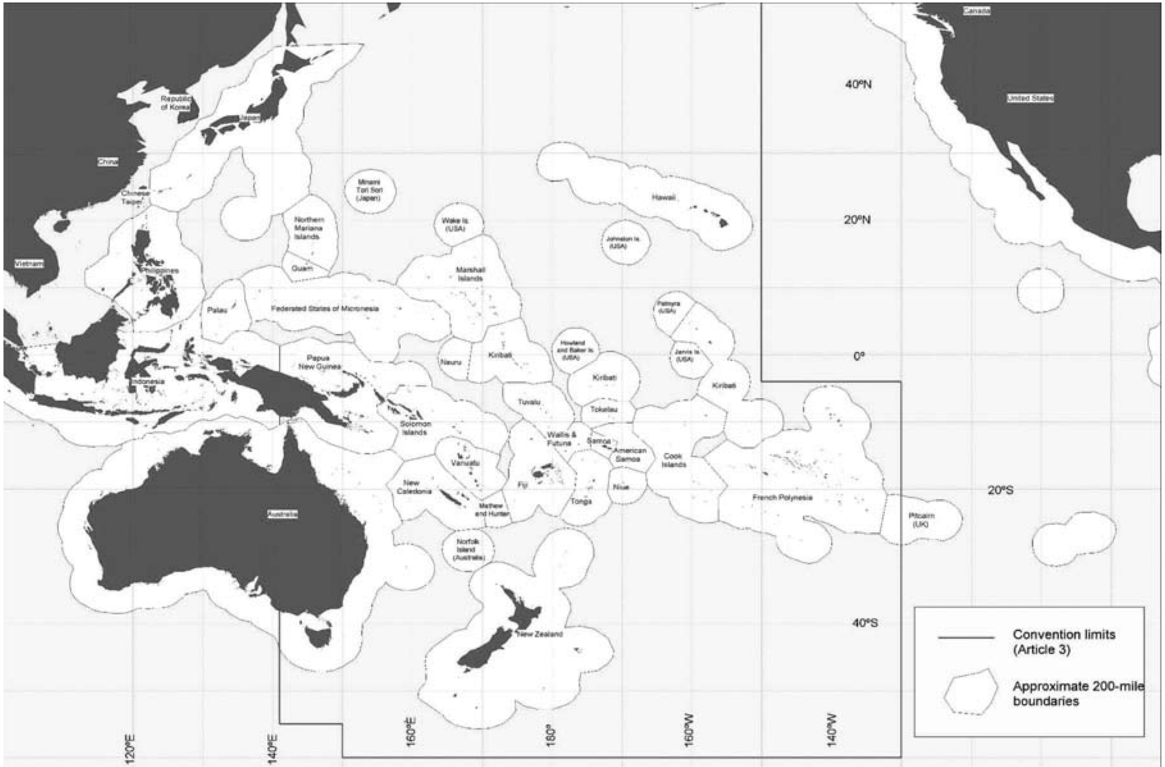
Study Area

In reference to the fisheries of the Pacific island region, there is often uncertainty over the geographical area involved. It could range in size from the entire western and central Pacific Ocean (WCPO) to the coastal waters of the countries of the region. In this report, the "region" consists of the internal waters and 200-mile zones of the 22 Pacific island countries and territories[1] plus the international waters in the tropical areas covered by the Western and Central Pacific Fisheries Commission (WCPFC). This can be seen within the wider WCPFC area covered in Figure 1.1.

Summary details of the geography and populations of the Pacific island countries are given in Table 1.1.

[1] For simplicity, the term "Pacific island countries and territories" is shortened to "countries" in the remainder of this report, except where they are discussed separately.

Figure 1.1: Area Covered by the Western and Central Pacific Fisheries Commission



Source: Western and Central Pacific Fisheries Commission.

Table 1.1: The 22 Pacific Island Countries and Territories

Country or Territory	**Land Area** (square kilometer)	**Area of 200-Mile Zone** (square kilometer)	**Estimated Population**[a] (July 2007)
Independent Pacific Island Countries			
Cook Islands	180	1,830,000	15,473
Federated States of Micronesia	702	2,978,000	109,999
Fiji Islands	18,376	1,290,000	834,278
Kiribati	726	3,550,000	93,707
Marshall Islands	720	2,131,000	52,701
Nauru	21	320,000	9,930
Niue	258	390,000	1,587
Palau	500	629,000	20,162
Papua New Guinea	461,690	3,120,000	6,332,751
Samoa	2,934	120,000	179,478
Solomon Islands	29,785	1,340,000	503,918
Tonga	696	700,000	102,264
Tuvalu	26	900,000	9,701
Vanuatu[b]	12,189	680,000	227,146
Pacific Island Territories			
American Samoa	197	390,000	65,029
French Polynesia	3,521	5,030,000	260,072
Guam	549	218,000	173,995
New Caledonia	19,103	1,740,000	242,561
Northern Mariana Islands	475	1,823,000	64,050
Pitcairn Islands	5	800,000	54
Tokelau	12	290,000	1,170
Wallis and Futuna	124	300,000	15,369

[a] From the Secretariat of the Pacific Community (2008a).

[b] The fish catches made in the Mathew/Hunter area (claimed by both Vanuatu and New Caledonia) are not included in this report.

Sources: Gillett and Preston (1997), SPC (2008a).

Definitions

This study places fish harvests in the Pacific islands in six production categories. By using a classifying scheme that focuses on the fate of the catch (rather than on type of fishing), many of the difficulties that arise in classifying fisheries (e.g., the indistinct boundary between subsistence and small-scale commercial fisheries) are avoided. The categories are:

- **Coastal subsistence**. The catch that is retained for consumption by the fisher or given away to family or friends. For simplicity, catches from recreational fishing[2] are also included.
- **Coastal commercial.** The catch that is sold and that comes from fishing operations in lagoons, reefs, deep slopes, and shallow seas. This category also includes fish caught by trolling and/or handlining from small vessels in the open sea adjacent to islands.
- **Offshore locally based.** The catch from industrial-scale tuna fishing operations that (i) are based at a port in the Pacific islands, and (ii) are generally from more than 12 nautical miles offshore. McCoy (1991) further defines "industrial fishing" as those operations that offload the catch primarily to a fish plant or processing facility.
- **Offshore foreign-based**. The catch from industrial-scale tuna fishing operations that are based at ports outside the Pacific islands.
- **Aquaculture.** The production from the farming of aquatic organisms, including fish, mollusks, crustaceans, and aquatic plants. Farming implies an intervention in the rearing process to enhance production, such as regular stocking, feeding, or protection from predators (FAO 1997).
- **Freshwater.** The catch from streams, rivers, and lakes, whether for subsistence or for commercial purposes.

Some additional terminology clarifications are as follows:

- In this report, "fishing" is considered as the harvesting of aquatic animals and plants, and includes aquaculture, unless otherwise stated.
- Similarly, "fisheries" is considered to be an inclusive term and includes aquaculture and postharvest activities.
- For GDP purposes, the economic sector is "fishing" rather than the more inclusive "fisheries." In this report, the term "fisheries sector" includes the "fishing sector" plus postharvest activities.
- "Fish" is defined (as in the legislation of most Pacific island countries) to be aquatic living organisms and the term includes invertebrates

[2] Commercial sport fishing (i.e., the activities of charter boats) is not covered in this report because data on this activity were found for one country only.

and plants. To emphasize the narrower definition of fish, the term "finfish" is used.

- The phrase "information not readily available" used in this report means that the information may exist, but could not be located despite intensive searching by the consultant for several days in country and as opportunities arose over a period of several months.

National Accounts, GDP, and Fishing

National accounts are an accounting framework used to measure the current economic activity in a country.[3] Most of the countries in the Pacific publish national accounts. The method used in each country is generally based on a standardized System of National Accounts (SNA) that was originally introduced by the United Nations in 1953. The SNA has since been revised, refined, and was republished in 1993 (SNA 1993). It is currently being modified and is likely to be published again in 2009 or 2010. For this present study, no major changes that will have an impact on the fishing sector are anticipated in the revision, and as SNA (1993) is current at the time of writing, that version is used here.

In practice, while the methods used to construct national accounts are based on a standardized system, there are different approaches that can be used and the quality of the data available can vary significantly. There may be substantial differences in the methods used by each country, so care should be exercised when making cross-country comparisons. In a few cases, the methods used in a country have changed; hence, comparisons over time for those countries should also be approached with caution.

Gillett and Lightfoot (2001) gave considerable attention to points in SNA (1993) that are especially important to the fishing sector, reproduced as Appendix 1. In brief, these are:

Fishing versus Fisheries. The sector according to SNA is "fishing," rather than the more inclusive "fisheries." Postharvest activities, including fish processing, are not included in the fishing sector; they are generally counted in manufacturing and other sectors. Both aquaculture and subsistence fishing are considered by SNA to be components of the fishing sector. Unless otherwise

[3] Much of this section is taken directly from Gillett and Lightfoot (2001). A more comprehensive description of national accounting is covered in most macroeconomic textbooks. In addition, the supporting document to the System of National Accounts (SNA) 1993 provides a comprehensive description of the procedures and conventions used in preparing national accounts.

stated, this report follows the SNA convention—and for GDP purposes, the sector is "fishing" and does not include any postharvest activities.

Residency. The nature and extent of residency is a core concept of the SNA. It defines what shall be counted as domestic product. For goods and services to be included in the GDP of a particular country, a resident of that country must produce them. A resident is an individual or enterprise whose "center of economic interest" is within the country. The residency concept is especially important in several Pacific island countries that have locally based foreign longliners, or that have purse seiners that fish in the zones of other countries. For one country covered in this study, a careful interpretation of SNA residency rules resulted in the consultant's estimate of fishing contribution to GDP that was about 60 times that of the figure calculated by the national statistics agency.

Weaknesses of the GDP concept. It must be kept in mind that GDP is an *estimate* of economic activity; it is seldom a precise calculation. Even though the SNA sets out fairly straightforward procedures, in practice, the analyst is usually confronted with many uncertainties. Another difficulty is that GDP is an imperfect indicator of the flow of economic benefits from economic activity. This can be quite important in countries where, according to SNA, locally based foreign fishing is part of the local economy but where much of the profits are remitted overseas. The net effect of fishing on economic activity, the "multiplier effect" (Appendix 2) can give more information than GDP contribution, but in practice can be difficult to calculate.

Appendix 3 contains guidelines for calculating the fishing contribution to GDP. It gives some overall considerations, general information on value-added ratios (VARs), VARs determined from 22 fishery studies in the Pacific islands, and the VARs used in this report for 14 categories of fisheries and aquaculture.

Structure of the Report

In the following chapters, information on benefits from fisheries is provided for each Pacific island economy. These chapters contain the most recent and readily available data on

- recent annual fishery harvests: quantities and values covering the six fishery production categories: (i) coastal commercial fishing,

(ii) coastal subsistence fishing, (iii) locally based offshore fishing, (iv) foreign-based offshore fishing, (v) freshwater fishing, and (vi) aquaculture;

- fishing contribution to GDP: the current fishing contribution, how it was calculated, and a production approach recalculation based on annual harvests obtained during the study;
- fishery exports: amounts, types, and the share in all exports;
- government revenue from the fisheries sector: access fees and other revenues;
- fisheries employment; and
- fisheries contribution to nutrition.

The information presented generally covers the period since the 2001 study but in some cases there have not been any new data. Most often, employment and nutrition lacked new data.

For most areas listed above, the country sections simply cite and summarize existing studies. In all countries, considerable analysis and, in some cases speculation bordering on guesswork were required to determine the amounts and values of recent annual fisheries harvests in the six production categories.

The 14 Independent Pacific island countries are listed first, followed by the eight Pacific island territories. There is also a section on fishery harvests in the seven bodies of international water in the CWPO.

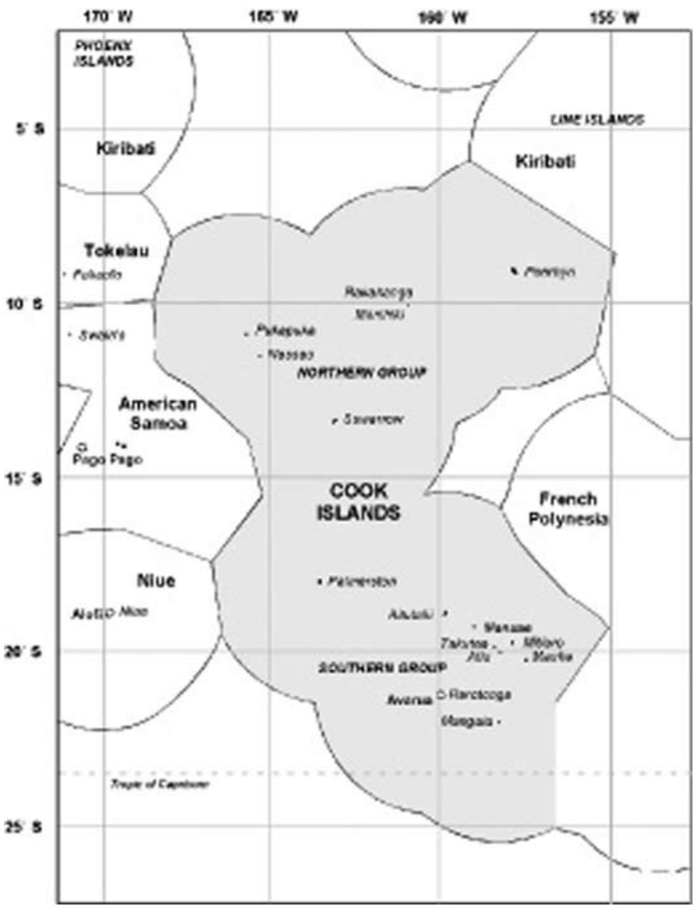
Features of regional production and value and how they have changed in the past decade are also outlined, followed by discussion of the absolute and relative benefits—and their measurement—to the various countries and territories. The implications for both fishers and the resources of climate change and changes in fuel costs are summarized. Finally, attention is drawn to several aspects related to fisheries benefits and some recommendations offered.

Appendixes give additional details on the previous (2001) study, national accounting and methods of calculating contributions to GDP, and the effects of climate change and changing energy costs on the fisheries sector in the Pacific.

PART B

Fishery Benefits in the Independent Pacific Island Countries

Cook Islands



Source: Secretariat of the Pacific Community.

Fish Production

Coastal Commercial Catches

Annual commercial fisheries production, based on data from late 1980s and early 1990s, was estimated at 124 tons (t) valued at $314,761 (Dalzell et al. 1996). In 2000, commercial production consisted of an estimated 80 t of food fish valued at NZ$650,000; pearls at NZ$18.4 million; aquarium fish at NZ$252,000; and trochus at NZ$200,000, according to senior officials of the Ministry of Marine Resources (MMR). An estimate for the late 1990s was 80 t for coastal commercial fishing and pearl farming (together worth NZ$19.5 million) (Gillett and Lightfoot 2001).

A 2007 study showed that the annual catch from the fish-aggregation-device (FAD) fishery by subsistence and semi-commercial fishers in recent years averaged 20–50 t, with 49.3 t caught in 2007 (MMR 2008). Average price of whole fish at the domestic market was around $8/kilogram (kg). Assuming that one-third of the 49.3 t was sold and the farm-gate pricing for subsistence catches was applied, then production can be estimated as a commercial catch of 16.4 t valued at NZ$131,280 and subsistence catch of 32.8 t valued at NZ$183,680. The report noted that, although the information was the best available, the data (especially the FAD catches) may not be very accurate (I. Bertram, personal communication, January 2009).

The MMR study also reported that 300–500 t of commercial and subsistence catches were harvested annually from inshore fisheries (i.e., reef fish and shellfish). In 2007, the main semi-commercial inshore fisheries of trochus, parrotfish, and live reef fish had mixed performances. No trochus harvest was reported in 2007, 18 t of parrotfish were marketed in Rarotonga at NZ$12/kg, and 1,500–1,600 aquarium fish worth NZ$54,000 were exported. Assuming that one-third of the inshore catch was sold, the market price was NZ$9/kg, and that farm-gate pricing could be applied to subsistence production, there would be a commercial production of about 133 t valued at about NZ$1.4 million and a subsistence production of about 267 t worth NZ$1.7 million.

The Cook Islands household expenditure survey in FY2006 showed a total expenditure of NZ$5,091,700 on "fish including shellfish" (Statistics Office 2007). Unpublished data supplied by the SPC Statistics and Demography Programme provided additional information on coastal commercial and/or subsistence production (Table 2.1).

Table 2.1 suggests that in FY2006, commercial fisheries production was 139 t and subsistence production was 239 t. To obtain an estimate of *coastal* commercial production, some adjustments need to be made for expenditure on fish from offshore fishing and for the export of aquarium fish.

The household expenditure survey concluded that the estimates of coastal fisheries production are reasonably close to those of the MMR report. The studies give similar results for coastal commercial fisheries (within 7%) and for subsistence fisheries (within 20%).

Indications exist that production from small-scale fisheries in the Cook Islands has fallen in recent years. The population in the predominantly fish-

Table 2.1: Fishery Production Information from the Household Expenditure Survey (kg)

Product	Bought			Caught			Total		
	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total
Tuna	9,319	35,928	45,247	43,287	22,069	65,356	52,606	57,998	110,603
Flying fish	636	693	1,329	545	412	957	1,181	1,105	2,286
Frozen fish	0	4,369	4,369	0	693	693	0	5,062	5,062
Other fresh and/or frozen fish	10,287	32,429	42,716	106,949	30,703	137,652	117,235	63,133	180,368
Paua	1,947	7,784	9,731	12,165	3,410	15,575	14,112	11,194	25,306
Mussels	144	9,799	9,943	49	0	49	193	9,799	9,992
Octopus and/or squids	0	6,937	6,937	3,851	6,528	10,379	3,851	13,465	17,316
Crabs	1,399	8,026	9,425	5,721	0	5,721	7,120	8,026	15,146
Seaweed	1,604	542	2,146	1,008	249	1,256	2,611	791	3,402
Kina	0	0	0	0	207	207	0	207	207
Smoked fish	0	262	262	59	0	59	59	262	321
Snapper	0	3,354	3,354	33	0	33	33	3,354	3,387
Other shellfish	458	3,469	3,928	1,246	116	1,362	1,704	3,586	5,290
Total	**25,792**	**113,594**	**139,386**	**174,913**	**64,387**	**239,300**	**200,705**	**177,981**	**378,686**

kg = kilogram.

Source: Unpublished household expenditure survey data.

eating outer islands has decreased, while fish consumption in the expanding Rarotonga population has been tempered by a ciguatera outbreak a few years ago. Movement of fish from the outer islands to Rarotonga has been constrained by a recent decrease in capacity of local cargo vessels.

For the purpose of this study, the annual production from coastal commercial fisheries in the Cook Islands in the mid-2000s was estimated at 133 t valued at about NZ$1.4 million.

Coastal Subsistence Catches

The annual subsistence catch was estimated at 858 t valued at $3,047,683—based on data from late 1980s and early 1990s (Dalzell et al. 1996). The estimate for 2000 was 795 t valued at about NZ$2 million (MMR 2001).

Following the analysis above that used more recent data together with earlier information, it is estimated that annual production from coastal subsistence fisheries in the Cook Islands in the mid-2000s was 267 t valued at NZ$1.7 million.

Locally Based Offshore Catches

The Cook Islands has two sub-fleets participating in offshore fishing. Vessels operating north of 15° south latitude target albacore tuna and unload at canneries in Pago Pago, American Samoa.[4] Vessels operating in the southern part of the zone set shallower, targeting swordfish and other associated species either for export or for sale at the local market. Some 35 longline vessels and 1 troll vessel were licensed to fish in the (Western and Central Pacific Fisheries Commission (WCPFC)) area in 2007, with the majority of the longline vessels concentrating their efforts at the Cook Islands exclusive economic zone (EEZ) (Anon 2008a).

Estimates of catches and values of the four main commercial species of tuna in the WCPFC area were made by the FFA (FFA 2008), using data sourced from the Oceanic Fisheries Programme of the SPC. Bycatch, although it is an important component of locally based offshore longline fisheries, was not included. Table 2.2 gives the FFA (2008) tuna catch estimates modified to include bycatch, as noted in the table.

The catch values given in FFA (2008) cannot be used in estimating total value due to the atypical marketing channels for the fish from Cook Islands longlining. The following alternative data appear more reliable:

- The catch in the northern (i.e., Manihiki, Rakahanga, and Penrhyn) fishery was valued at NZ$7.68 million in 2006 and NZ$5.54 million in 2007 (MMR 2008).

Table 2.2: Catches by Cook Islands Offshore Vessels (t)

	2002	2003	2004	2005	2006	2007
Longline tuna catch[a]	769	2,462	3,343	3,247	2,972	2,819
Troll tuna catch	166	688	528	212	254	254
Total catch	**1,166**	**3,889**	**4,874**	**4,433**	**4,118**	**3,919**

t = ton.

[a] The longline catch was increased by 30% to include bycatch.

Source: Modified from Forum Fisheries Agency (2008).

[4] Because these vessels are registered in the Cook Islands and fish predominantly in Cook Islands waters, they are considered in this report to be "offshore locally based."

- Using the partition in catch between the northern and southern fisheries given in MMR (2008) and marketing information in Philipson (2006), the dockside value of the catch in the southern fishery is estimated to be NZ$2.34 million in 2006 and NZ$1.64 million in 2007.
- The value of the offshore troll fishery was $679,088 (NZ$1,045,796) in 2006 and $494,792 (NZ$672,917) in 2007 (FFA 2008).

From the above, the total value of all three fleets is estimated to be NZ$11.1 million in 2006 and NZ$7.85 million in 2007.

Foreign-Based Offshore Catches

In this study, offshore vessels registered in the Cook Islands that fish mainly Cook Islands waters from either Rarotonga or Pago Pago are considered "locally based."

The only foreign vessels authorized to fish in the Cook Islands zone are purse seiners fishing under the United States (US) multilateral treaty. Unpublished US National Marine Fisheries Service (NMFS) public domain data show the following catches made in recent years by US purse seiners in the waters of the Cook Islands, during licensing period:

- June 2006–June 2007: 7.5 t
- June 2005–June 2006: 45.4 t
- June 2004–June 2005: 0.0 t
- June 2003–June 2004: 0.0 t

FFA (2008) data indicate that the values of these catches, by calendar year, were as follows:

- 2003: $0
- 2004: $4,166
- 2005: $110,309
- 2006: $15,621
- 2007: $0

Freshwater Catches

A significant catch of eels on Mitiaro was reported, tilapia are commonly caught on many islands, and apart from the introduced giant freshwater prawn (*Macrobrachium rosenbergii*), six species of freshwater prawns were recorded (FFA 1993). However, the Secretary of Marine Resources believes that *M. rosenbergii* is no longer present in the Cook Islands; the prawns did not establish a permanent population due to the small river systems (I. Bertram, personal communication, January 2009).

For the purpose of the present study, it is estimated that annual freshwater fishery production in the mid-2000s was 5 t valued at NZ$50,000.

Aquaculture Harvests

Pearls harvested in 2005 were just above 100,000; in 2006, about 190,000; and 186,725 in 2007, with 89% of the harvest from Manihiki and 11% from Rakahanga. The gross farm-gate value of the pearl harvest in 2007 was estimated to be NZ$3 million (MMR 2008).[5]

Apart from pearl culture, aquaculture production in the Cook Islands is small and limited to subsistence and semi-commercial production of tilapia, milkfish, and clams.

In 2007, 36,000 tilapia fry were imported by the MMR for a trial with a fish farmer in Rarotonga. After 8 months, the first harvest was around 8,400 tilapia with an average weight of 160–250 grams (MMR 2008). The Secretary of Marine Resources (I. Bertram, personal communication, January 2009) stated that the tilapia farm operator harvests about 70–150 fish weekly, depending on demand from the previous week.

The MMR hatchery produced 3,058 live giant clams in 2007. Some 1,858 were exported for the aquarium trade, up from 320 juvenile clams in 2006. An additional 1,200 clams were transferred to Rarotonga for the construction of coral gardens for tourists. The average price per clam was NZ$3.40 at the farm gate (MMR 2008). The Secretary of Marine Resources (I. Bertram, personal communication, January 2009) indicated that the hatchery's production had increased since 2007. About 40,000 clams were produced in a one-month period in late 2008.

Anecdotal information suggests that milkfish stocks are relatively abundant in the northern islands, but low in Mitiaro.[6] A small milkfish harvest was made in 2007 from a research growth trial on Rarotonga (MMR 2008).

The data are summarized in Table 2.3. For the purpose of the present study, it is estimated that aquaculture production in 2007 was about 190,000 pieces and 3 t worth about NZ$3.04 million.

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5 This apparently includes the value of pearl shell.

6 The Secretary of Marine Resources believes that a milkfish population was never established on Mitiaro.

Table 2.3: Aquaculture Production in the Cook Islands, 2007

Product	Production	Value (NZ$)
Pearl and pearl shell	186,725 pearls plus shell	3,000,000
Tilapia	1,680 kg	16,680
Giant clam	3,058 pieces	10,397
Milkfish	not available	not available

kg = kilogram, NZ$ = New Zealand dollar.

Source: Consultant's estimates.

Summary of Harvests

From the above sections, an approximation of the annual catches and values[7] of the fishery and aquaculture harvests in 2007 can be made (Table 2.4).

Table 2.4: Fisheries and Aquaculture Harvests in the Cook Islands, 2007

Harvest Sector	Quantity (t)	Value (NZ$)
Coastal commercial	133	1,400,000
Coastal subsistence	267	1,700,000
Offshore locally based	3,939	7,850,000
Offshore foreign-based	0	0
Freshwater	5	50,000
Aquaculture (pieces and weight)	190,000 pieces plus 3	3,040,000
Total	**190,000 pieces plus 4,347**	**14,040,000**

NZ$ = New Zealand dollar, t = ton.

Source: Consultant's estimates.

Contribution of Fishing to GDP

Current Official Contribution

A summary of the national accounts of the Cook Islands is given in Statistics Office (2008). Staff of the Statistics Office kindly provided a disaggregation of the "agriculture and fishing" component, from which the fishing contribution

7 The values in the table are dockside and/or farm-gate prices.

Table 2.5: Cook Islands GDP and Fishing Contribution (NZ$'000)

Item	2001	2002	2003	2004	2005	2006	2007
GDP	205,679	220,550	246,038	258,428	261,347	277,649	286,711
Fishing contribution to GDP	13,528	15,610	20,411	17,640	18,125	16,752	18,113
Share of fishing in GDP (%)	6.6	7.1	8.3	6.8	6.9	6.0	6.3

GDP = gross domestic product, NZ$ = New Zealand dollar.

Sources: Statistics Office (2008) and unpublished data of the Statistics Office.

to GDP was determined (Table 2.5). Discussions with Statistics Office staff confirmed that "fishing" includes subsistence, small-scale commercial, locally based offshore, and aquaculture (T. Tangimetua, personal communication, October 2008).

Method Used to Calculate the Official Fishing Contribution to GDP

Staff of the Statistics Office provided the following details on the method used to calculate the fishing contribution to GDP:

- In 2004, the Statistics Office began working closely with the MMR.
- To determine the value added from subsistence fishing, the Statistics Office uses data from MMR and from household surveys. Statistics Office staff believe that the latter uses a better sampling strategy.
- For small-scale commercial fishing, the data are from surveys of incorporated businesses.
- For large-scale fishing, the data are from MMR and prices from the canneries in Pago Pago.
- For pearl culture, free on board (FOB) export values are used as the value added.

Given the level of detail available, only limited comment can be made on the methodology. It is likely that "surveys of incorporated businesses" may miss small-scale commercial fishing operations. If the value added for pearl culture is taken to be simply the FOB value of the product, then errors are introduced by not considering intermediate consumption and by not using farm-gate values. These two problems may also apply to the value-added calculations for other forms of Cook Islands fishing.

Alternative Estimate of Fishing Contribution to GDP

Table 2.6 presents an alternative to the official method of estimating fishing contribution to GDP in the Cook Islands. It is a simple production approach that takes the values of five types of fishing/aquaculture activities for which production values were determined and summarized in Table 2.4 above. This approach also determines the value added by using value-added ratios (VARs) characteristic of the type of fishing concerned. The VARs were determined by knowledge of the fisheries sector and use of previous studies (Appendix 3).

It is not intended that the approach in Table 2.6 replace the official methodology, but rather the results obtained can serve as a comparator to gain additional information on the appropriateness and accuracy of the official methodology—and possibly on a need for modification.

Table 2.6 was constructed using the gross value of production in 2007 for *only* the Rarotonga component of the offshore fleet (given in the section "Locally Based Offshore Catches"). The gross value of production for longliners based in Pago Pago is not included because those vessels have their base of operations in another country. The other values of production are the general "mid-2000s" values determined in earlier sections.

The 2007 fishing contribution to GDP of NZ$4,011,000 is considerably less than the official fishing contribution to GDP of NZ$18,113,000 in Table 2.5. Two possible reasons for the large difference are (i) the use of the gross value of production from each type of fishing as the value added (i.e., not subtracting the intermediate consumption), and (ii) inclusion of the activities of offshore fishing vessels that are not based in the country.

Table 2.6: Fishing Contribution to GDP in 2007 Using an Alternative Approach

Harvest Sector	**Gross Value of Production** (NZ$, from Table 2.4)	**Value- Added Ratio**	**Value Added** (NZ$)
Coastal commercial	1,400,000	0.65	910,000
Coastal subsistence	1,700,000	0.80	1,360,000
Offshore Rarotonga-based	1,640,000	0.20	328,000
Freshwater	50,000	0.90	45,000
Aquaculture	3,040,000	0.45	1,368,000
Total			**4,011,000**

GDP = gross domestic product, NZ$ = New Zealand dollar.

Source: See Production section of this report.

Export of Fishery Products

Fishery product exports are compared to total exports in Table 2.7.

Table 2.7: Fishery and Other Exports (NZ$'000)

Product	2003	2004	2005	2006	2007
Live fish	281	135	111	141	62
Fish, fresh or chilled	8,258	2,898	3,381	1,066	3,129
Pearls	2,843	3,177	1,646	2,044	2,129
Pearl shells	49	37	3	3	278
Total fishery product exports	**11,431**	**6,247**	**5,141**	**3,254**	**5,598**
Total exports	**14,588**	**10,771**	**7,417**	**5,420**	**7,052**
Share of fishery products in total exports (%)	**78.4**	**58.0**	**69.3**	**60.0**	**79.4**

NZ$ = New Zealand dollar.

Source: Statistics Office (2008).

MMR (2008) commented on the exports of the important fishery commodities, as follows:

- The total value of fresh or chilled fish exports for 2007 rose by 195% to NZ$3.14 million compared to $1.06 million in 2006 due to a large shipment to the People's Republic of China in the third quarter of the year. That market in 2007 accounted for around 80%–90% of the total value of fish exports, with the remaining 10%–20% to Japan. In addition to exports to these two markets, a trial shipment of tuna loin of around 33 t was exported to New Zealand in the fourth quarter of 2007.
- The estimated value of catch in 2007 from the northern fishery offloaded in American Samoa for canning fell 29% from NZ$7.68 million in 2006 to NZ$5.54 million. An overall drop in total catch, coupled with a weak US dollar, drove down the value of catch from the fishery.
- The strong New Zealand dollar and low pearl production continued to dampen export returns despite world pearl prices recovering in recent years. New Zealand, Australia, and Japan remained the main markets for pearls, although there had been a sharp increase in exports to the US, buoyed by a growing pearl jewelry market.
- Around 1,858 live juvenile clams, mainly *Tridacna derasa*, were supplied for export to the aquarium trade, up from 320 in 2006.

- The main export markets for live reef fish are the US and Japan. In 2007, the value of live fish exports totaled NZ$54,000, dropping to 62% from NZ$141,000 in 2006.

Government Revenue from Fisheries

Access Fees for Foreign Fishing

The only foreign fishing vessels authorized to fish in the waters of the Cook Islands in recent years are US purse seiners. Under the terms of the US multilateral tuna treaty, the Cook Islands and other Pacific island countries receive payments from the US government and the US tuna industry that are associated with fishing access by US purse seine vessels. Some Pacific island countries consider that all payments under the US treaty are for fishing access, while others treat some components as aid. Table 2.8 gives the payments to the Cook Islands in recent years.[8]

These payments represent about 0.4% of the "total crown receipts" of NZ$86.0 million listed in the FY2008 budget estimate (Maoate 2008).

Other Government Revenue from Fisheries

The other significant sources of direct government revenue from fisheries activities are license fees for domestic offshore vessels. According to the

Table 2.8: Payments to the Cook Islands from the US Tuna Treaty

Licensing Period	15% Shares [a]	85% Shares [b]	PDF Shares [c]	Total ($)
June 2003–June 2004	147,357.28	0.00	111,125.00	258,482.28
June 2004–June 2005	147,310.43	0.00	111,125.00	258,435.43
June 2005–June 2006	147,209.70	12,350.57	111,125.00	270,685.27
June 2006–June 2007	145,860.78	2,378.62	111,125.00	259,364.40

PDF = Project Development Fund.

[a] The "15% shares" ($2,042,050.92 in 2008) are shared equally between all countries that are parties to the treaty.

[b] The "85% shares" ($14,273,117.87 in 2008) are apportioned to countries based on where the catch by US vessels is made. These amounts in the table are zero because US seiners have not attempted to fish in the Cook Islands in over 20 years.

[c] The "PDF shares" ($1,555,750.00 in 2008) are shared equally between all countries that are parties to the treaty for project development work.

Source: National Marine Fisheries Service (of the United States) unpublished public domain data.

[8] In the table, the amounts listed are as though all fees are for "access."

MMR licensing officer, these fees in recent years were as follows: FY2006, NZ$95,000; FY2007, NZ$110,000; and FY2008, NZ$220,000 (J. Marurai, personal communication, October 2008).

Employment

Following are some general features of employment in the Cook Islands relevant to the fisheries sector (ADB 2008a):

- Expanding tourism and rising household spending have reduced unemployment on the main island of Rarotonga to low levels. Rising numbers of foreign workers are required to meet the needs of the island's expanding private sector.
- The Cook Islands has, by far, the highest wages of any independent Pacific island country.
- Employment in agriculture and fisheries dropped from about 30% of the labor force in early 1980s to less than 5% in 2001.
- Pearl farming is the major area of private sector employment in the outer islands.

The Cook Islands 2001 Census of Population and Dwellings had a limited amount of information specifically on fisheries employment. Of the employed population recorded in the census (5,928 people), 427 (7.2%) indicated they were employed in "agriculture and fishing." Of those people, 183 were on Rarotonga (Statistics Office 2003).

The employment situation in subsistence fishing was very different between Rarotonga and the outer islands. A recent SPC survey on Mangaia indicated that almost all households (92%) were engaged in fisheries with an average of 1 to 2 fishers each. In total, there were 309 fishers on Mangaia, including 148 women and 161 men. One-third (111) of all fishers were men exclusively catching finfish and about another third (101) were women exclusively harvesting invertebrates. The remaining fishers were doing both (Kronen and Solomona 2008a).

A similar SPC survey on Rarotonga showed that less than half of all households (44%) were engaged in fisheries, with an average of one fisher per two households. These figures also included sport fishers and households having a motorized boat used for weekend trolling outside the outer reef. About half (155) of all fishers were predominantly men targeting finfish. About a quarter of the fishers (69) were women exclusively harvesting invertebrates. The remaining fishers were doing both (Kronen and Solomona 2008b).

ADB (2008a) described the pearl farm employment situation on Manihiki and Rakahanga as follows:

- The Manihiki pearl farm workforce in 2000 consisted of household members and others. In the former category were 103 pearl farm operators working an average of 15 hours/week, 32 paid workers working an average of 34 hours/week, and 90 unpaid workers working an average of 9 hours/week. In the other category were 37 paid workers and 13 unpaid workers. Workers were mainly men: 203 compared with 72 women. The average wage for paid laborers was NZ$435/month, with 1 in 5 workers receiving free housing and/or food. Of the 103 pearl farm operators, 24 respondents indicated that they derived all their income from the pearl farm, 13 derived half to three-quarters, and 38 derived one-quarter to one-third.
- The Rakahanga pearl farm workforce in 2000 included among household members 11 pearl farm operators working an average of 6 hours/week and 17 unpaid workers working an average of 8 hours/week. One other paid worker worked 30 hours/week and another was unpaid. Of the workers, 29 were males and 1 female. The average wage for paid labor was NZ$125/month. Free food and/or housing were provided to two workers.

The Secretary of Marine Resources offered an alternate view on the Rakahanga pearl farm workforce in 2000. He indicated that there was actually one community farm with mainly unpaid workers (the farm was to raise funds for the church). Most of the work was done on a very informal basis and, therefore, difficult to quantify (I. Bertram, personal communication, January 2009).

Recent information (R. Newnham, personal communication, October 2008) indicates there were only 32 active pearl farms in the Cook Islands in October 2008. It is likely that present employment related to pearl farming is considerably less than that described above for 2000.

The numbers of small-scale commercial operators, mainly trolling and midwater fishing around FADs for tunas and other pelagic fish, were as follows: Rarotonga, 20 full-time and 20–25 part-time; and Aitutaki, 5 full-time and 10–15 part-time. There were also several hundred operators in the outer islands fishing around FADs at a subsistence level (Chapman 2004).

Employment in offshore tuna fishing in recent years is shown in Table 2.9. Barclay and Cartwright (2007) observed that the early aspirations for the employment of Cook Islanders in the tuna industry, particularly on fishing vessels, were not fulfilled. The Cook Islands has a labor shortage: there

Table 2.9: Employment in the Tuna Industry

Item	2002	2006	2008
Local jobs on vessels	50	15	12
Local jobs in shore facilities	15	15	10
Total	**65**	**30**	**22**

Source: Gillett (2008).

is not the unemployment problem that exists in other Pacific island countries, such as the Fiji Islands, Papua New Guinea, and Solomon Islands. Work on fishing vessels is physically hard; some vessels stay out fishing for months at a time and the pay is not high for ordinary crew. Cook Islanders have taken up employment opportunities on some of the small vessels operating from Rarotonga that do not stay out at sea, and in processing facilities.

Fish Consumption

Annual per capita consumption of fish on Tongareva Island was estimated at 219.0 kg (Passfield 1997). For the whole Cook Islands, it was estimated at 63.2 kg in 1995, based on Food and Agriculture Organization of the United Nations (FAO) data on production, imports, and exports (Preston 2000). Another national estimate around that time was 47.0 kg (MMR 2000).

For Rarotonga, surveys showed per capita daily seafood consumption to be 317.7 g in1989 and 270.7 g in 2001[9] (on an annual basis, 115.9 kg and 98.8 kg, respectively) (Tuatai 2001). Another survey, in September 2006 (Moore 2006), indicated a further decline to 176 g per capita per day in 2006[10] (64.2 kg/year). The decrease in finfish consumption was attributed to many factors, including ciguatera, marine protected areas (MPAs), changes in the lifestyle of residents, and the high cost of finfish as opposed to meat products. Where lagoon and reef species were consumed, they were generally received from the outer islands.

SPC carried out some recent studies in the Cook Islands that allow seafood consumption in Rarotonga to be compared to other islands in the country. Table 2.10 gives the results from Rarotonga and Mangaia.

9 Discussions with the author indicate that the per capita consumption was a mixture of whole fish weight equivalent and food weight (T. Tuatai, personal communication, October 2008).

10 The text of the report is not clear whether the per capita consumption is whole fish weight equivalent or food weight.

The major change in fish consumption in Rarotonga during 1998–2008 was the availability of fish from longliners. The domestic market absorbed around 40%–50% of total catch from the longline vessels based in Rarotonga. In 2007, about 120–150 t of whole fish equivalent were sold domestically to the tourism industry and the local population on Rarotonga (MMR 2008).

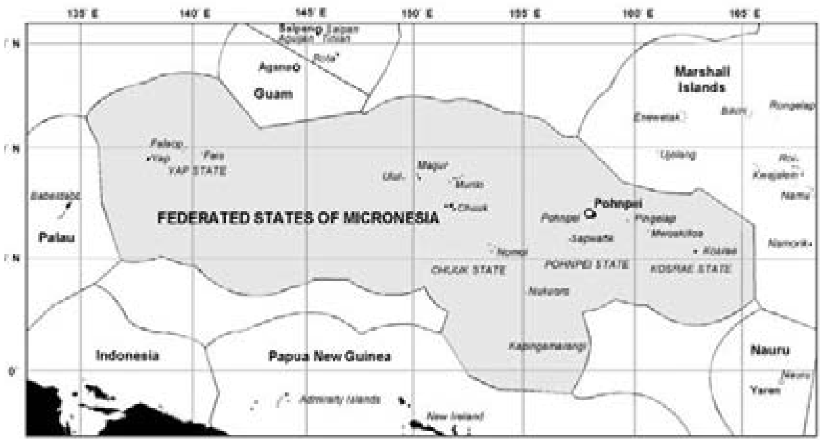
A household income and expenditure survey (HIES) in FY2006 showed that for the whole of the Cook Islands, annual per capita fish consumption (whole weight equivalent) was 34.9 kg, of which 81% was fresh fish. For rural areas the figure for per capita consumption of fish was 60.9 kg, and for urban areas, 24.8 kg (Bell et al. 2008).

Table 2.10: Seafood Consumption on Rarotonga and Mangaia

Rarotonga	
Fresh fish consumed (kg/capita/year)	31.66 (±4.62)
Frequency of fresh fish consumed (times/week)	1.85 (±0.17)
Fresh invertebrates consumed (kg/capita/year)	1.43 (±0.61)
Frequency of fresh invertebrate consumed (times/week)	0.33 (±0.08)
Canned fish consumed (kg/capita/year)	10.88 (±2.02)
Frequency of canned fish consumed (times/week)	1.16 (±0.19)
Mangaia	
Fresh fish consumed (kg/capita/year)	65.71 (±13.39)
Frequency of fresh fish consumed (times/week)	3.16 (±0.26)
Fresh invertebrates consumed (kg/capita/year)	7.54 (±2.05)
Frequency of fresh invertebrate consumed (times/week)	0.72 (±0.11)
Canned fish consumed (kg/capita/year)	15.05 (±3.22)
Frequency of canned fish consumed (times/week)	1.13 (±0.19)

Sources: Kronen and Solomona 2008a and 2008b.

Federated States of Micronesia



Source: Secretariat of the Pacific Community.

Fish Production

Coastal Commercial Catches

Annual coastal commercial fisheries production for the early 1990s was estimated at 637 t worth $1.5 million (Dalzell et al. 1996), based on information from FFA fisheries profiles (Smith 1992a) and from a nutritional survey in FY1988 (Elymore et al. 1989). This estimate and four other sources were used to derive an estimate for the late 1990s of 5,000 t worth $14.5 million (Gillett and Lightfoot 2001). However, an official of the FSM government's Department of Resources and Development with substantial fisheries experience across FSM felt that the latter was too low (M. Henry, personal communication, October 2008). He cited a 1990s survey in which small-scale fisheries production (both commercial and subsistence) "was a million pounds per year in Chuuk alone."

For Pohnpei Island, total coastal fishery production was estimated to be about 1,780 t (75% reef/inshore, 25% pelagic) (Fisheries Engineering

1995). This was partitioned as subsistence catch (780 t) and commercial catch (1,000 t), of which about 28% was consumed by the commercial fishers themselves. An intensive survey carried out in 1998–2008 concluded that 475 t of reef fish were caught and sold in Pohnpei each year (Rhodes and Tupper 2007; Rhodes et al. 2007), considerably less than the finding of the Fisheries Engineering (1995) survey a decade earlier. However, the results did "not include subsistence catch, fish sold to schools and hospitals, or exports" (George 2008). Their inclusion leads to an estimated 680 t consumed annually on Pohnpei. Further, neither study covered catches of pelagic fish by coastal fisheries, which are made by both trolling and hand-lining in Pohnpei. Gillett and Lightfoot (2001) suggested that pelagic catches represent 25% of the fish from small-scale fisheries in FSM.

An HIES in 2005 indicated that $23,034,000 was spent on "fish and seafood," of which $15,732,000 (66%) were for "home produced" products and $9,200,000 for those purchased—presumably, from either local fisheries or imported (Statistics Division 2007a). Expenditure in Chuuk (for both home produced and purchased) represented about half of that for all FSM. The results of the HIES suggest that the value of subsistence fish is significantly greater than that from commercial fisheries and imported fish combined.

The value of coastal fishery exports is shown in Table 3.1. Because "Continental freight section" is listed as a source of data, the table presumably covers the informal exports as airline passenger baggage.

FAO fishery export statistics (FAO 2008) do not separate coastal fishery exports, but they show an export in 2006 of "coral and the like" valued at $151,000.

The population of FSM increased by 3.2% between 2001 (the period covered by the Gillett and Lightfoot estimate) and 2007. In terms of distribution of population between the states of FSM, 50.1% now live in Chuuk, 32.2% in Pohnpei, 10.5% in Yap, and 7.2% in Kosrae.

Table 3.1: Federated States of Micronesia Coastal Fishery Exports

Item		2000	2001	2002	2003	2004	2005	2006	2007
Reef fish	Weight (kg)	15,123	20,049	21,624	214,335	16,273	152,159	5,630	244,241
	Value ($)	75,273	100,823	109,512	733,022	55,650	520,382	241,421	841,376
Crab/ lobsters	Weight (kg)	17,097	14,140	22,314	6,142	3,651	6,311	2,193	6,887
	Value ($)	172,339	177,948	206,480	41,442	25,369	45,362	19,831	39,163
Trochus shell	Weight (kg)	0	0	9,562	0	0	0	135,100	23,714

kg = kilogram.

Source: Division of Statistics (2008).

The average price received by commercial small-scale fishers in Pohnpei was $1.87/kg in 1997, rising to $2.42 in 2006 (Rhodes et al. 2007). Fish were sold by fishers in Chuuk during most of the early and/or mid-2000s for $2.20/kg, and in mid-2008 for $2.97/kg (M. Henry, personal communication, October 2008).

Considering the above information, a crude revised estimate of FSM commercial coastal fisheries production was made by adjusting the Rhodes estimate for Pohnpei for export and institutional sales (George 2008), for coastal pelagic fishing (by ratios from Gillett and Lightfoot [2001]) and for other areas of FSM by ratios of population distribution. This methodology, albeit weak, resulted in an estimate of annual coastal commercial fisheries production in FSM in the mid-2000s of about 2,800 t. Assuming a price of $2.70/kg, this production was worth $7,560,000 to the producers.

Coastal Subsistence Catches

Subsistence production in early 1990s was estimated at 6,243 t worth $11.2 million (Dalzell et al. 1996), and in late 1990s at 5,000 t worth $10 million (Gillett and Lightfoot 2001). The 2005 HIES indicated that $15,732,000 of fish was "home produced" in FSM. At a price of $1.60/kg (70% of the 2005 market price of $2.30), the HIES value equated to about 9,800 t of annual subsistence fisheries production worth $15.7 million.

Locally Based Offshore Catches

Given the available data, estimation of catches by FSM-based longliners requires the assumption that all catches in the FSM exclusive economic zone (EEZ) by FSM-flagged longliners and PRC-flagged longliners are by vessels based in FSM, and that these FSM-based vessels fish entirely in the FSM EEZ. Individuals familiar with tuna fishing in FSM express the opinion that these assumptions are reasonable (E. Pangelinan and M. McCoy, personal communication, November 2008). Tuna catches in FSM waters by FSM- and PRC-flagged longliners are shown in Table 3.2.

These catches are modified for bycatch in Table 3.3, which takes the total longline catch of tuna from Table 3.2 and adds 30% for bycatch. It also takes the catch of tuna by FSM seiners from FFA (2008) and increases it by 5% for bycatch.

Table 3.2: Tuna Catches by Locally Based Longliners in Federated States of Micronesia (t)

Vessel Nationality	2003	2004	2005	2006	2007
Federated States of Micronesia	633	379	78	44	49
People's Republic of China	2,925	912	53	405	1,020
Total	**3,558**	**1,291**	**131**	**449**	**1,069**

Source: National Oceanic Resource Management Authority (NORMA) (2008).

Table 3.3: Catches by Locally Based Offshore Vessels in Federated States of Micronesia (t)

Gear type	2003	2004	2005	2006	2007
Longline	4,625	1,678	170	584	1,390
Purse seine	32,911	29,700	30,205	10,599	14,832
Total	**37,536**	**31,378**	**30,375**	**11,183**	**16,222**

t = ton.

Sources: Forum Fisheries Agency (2008) and consultant's estimates.

Table 3.4: Value of Catches by Locally Based Offshore Vessels in the Federated States of Micronesia Zone[a] ($)

Gear type	2003	2004	2005	2006	2007
Longline	25,981,629	10,247,501	1,043,545	3,461,922	8,366,856
Purse seine	9,583,639	20,949,954	21,777,637	7,928,233	15,541,521
Total	**35,565,268**	**31,197,455**	**22,821,182**	**11,390,155**	**23,908,377**

[a] Purse seine catch values were reduced by 15% for sea transport to get the catch to those markets (i.e., the value of the catch in Federated States of Micronesia waters). Longline catch values were reduced by 25% for air transport to those markets and increased by 10% to include bycatch sales.

Sources: Forum Fisheries Agency (2008) and consultant's estimates.

Table 3.4 places values on the catches in the table above. The values are the destination market values given in FFA (2008), modified for bycatch and shipment costs as shown in the table.

Foreign-Based Offshore Catches

Catches by foreign-based offshore vessels in the FSM zone in 2007 were estimated by taking all catches in the FSM as given in NORMA (2008) less the catches by FSM vessels in the FSM zone as estimated by SPC (unpublished information, 2008b). The tuna catch was then adjusted for bycatch (Table 3.5).

Table 3.5: Catches by Offshore-Based Foreign Vessels in the Federated States of Micronesia Zone, 2007 (t)

Type	Total Tuna Catch	Tuna Catch by FSM Vessels in FSM Zone	Foreign Tuna Catch in FSM Zone	Foreign Total Catch in FSM Zone
Purse seine	134,473	3,356	131,108	137,634
Longline	4,620	250	4,370	5,681
Pole and line	0	0	0	0
Total	**139,093**	**3,606**	**135,478**	**143,315**

FSM = Federated States of Micronesia, t = ton.

Sources: National Oceanic Resource Management Authority (NORMA) 2008, and Secretariat of the Pacific Community, unpublished data, 2008b.

Table 3.6: Value of the Foreign Catch in the Federated States of Micronesia Zone, 2007

Type	Foreign Total Catch in FSM Zone (t)	In-Zone Value ($)
Purse seine	137,634	152,085,570
Longline	5,681	25,110,020
Pole and line	0	0
Total	**143,315**	**177,195,590**

FSM = Federated States of Micronesia, t = ton.

Sources: Table 3.5 and Forum Fisheries Agency (2008).

The value of the catch in Table 3.5, based on the 2007 destination market prices given in FFA (2008), less 15% for transportation to those markets, are given in Table 3.6.

Freshwater Catches

The larger islands in FSM have freshwater streams and ponds in which freshwater fish and invertebrates are found, including eels, tilapia, and freshwater shrimp. The capture of eels is low due to cultural attitudes. The capture of tilapia is also low because the fish is perceived as an invasive species. Small amounts of freshwater shrimp are eaten. For the purpose of the present study, annual freshwater fisheries production in FSM in recent years is estimated to be 1 t worth $8,000.

Aquaculture Harvests

Presently, the only significant aquaculture operations in FSM are the culture of giant clams from the government aquaculture facility on Kosrae and black pearls on Nukuoro Atoll.

On giant clam aquaculture, unpublished data on the Kosrae facility from the FSM's Department of Resources and Development show the following annual clam sales: $8,000 in 2005, $17,000 in 2006, and $27,000 in 2007. An official of the department indicates that these were all sales for export (M. Henry, personal communication, October 2008). The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) gives exports of live clams from FSM as 10,118 in 2005, 13,374 in 2006, and 20,195 in 2007 (CITES 2008).

Pearl oysters (*Pinctada margaritifera*) have been cultured since 1994 on the remote atoll of Nukuoro. The farm is community-based (owned and operated by the municipal council) and has received funding and technical support since its inception. The farm produces black pearls and relies on the collection of wild spat (Lindsay 2002).

Discussions in October 2008 with members of the Nukuoro community selling pearls in Pohnpei revealed the following annual pearl harvests on Nukuoro: 3,000 pieces in 2005; none in 2006; 2,000 in 2007; and none in 2008. All the pearls are retailed in Pohnpei. The pearl sellers were unaware of farm-gate prices, but indicated that retail Pohnpei prices ranged from $20 to $480 per pearl.

For the purpose of the present study, annual aquaculture production in FSM in recent years is estimated to be 16,000 pieces of clams and pearls valued at $80,000.

Summary of Harvests

From the above sections, a crude approximation of the fishery and aquaculture harvests in 2007 was made[11] (Table 3.7). The extremely weak factual basis for the estimates of coastal commercial and coastal subsistence catches should be recognized.

11 The values in the table are dockside/farm-gate prices, except in the case of offshore foreign-based fishing where the value in local waters (overseas market prices less imputed transshipment costs) is given.

Table 3.7: Annual Fisheries and Aquaculture Harvest in the Federated States of Micronesia, 2007

Harvest Sector	Quantity (t)	Value ($)
Coastal commercial	2,800	7,560,000
Coastal subsistence	9,800	15,732,000
Offshore locally based	16,222	23,908,377
Offshore foreign-based	143,315	177,195,590
Freshwater	1	8,000
Aquaculture	16,000 pieces	80,000
Total	**16,000 pieces and 172,138 tons**	**224,483,967**

t = ton.

Source: Production tables above and consultant estimates.

Contribution of Fishing to GDP

Current Official Contribution

The Statistics Division does not give information on contribution to GDP by sectors, such as fisheries. Discussions with present and past staff of the Statistics Division and the Statistics Division data (2007b) indicate that the current GDP methodology is geared toward satisfying the requirements of the Compact of Free Association; and it is not necessarily the most appropriate methodology for the country. In theory, fishing by companies would be covered by information from social security and tax records while subsistence fishing would be covered by the HIES. Fishing carried out by small-scale commercial fishers may not be captured by government records (tax and/or social security) or the (1998) HIES. However, the 2005 HIES was designed to overcome this type of situation (G. McKinlay, personal communication, October 2008).

Alternative Estimate of Fishing Contribution to GDP

Table 3.8 estimates the fishing contribution to GDP based on the values of the five types of fishing/aquaculture activities (summarized in Table 3.7). Value added was determined by using VARs characteristic of the type of fishing concerned. The VARs were determined by knowledge of the fisheries sector and use of specialized studies (Appendix 3). The total value added from fishing in calendar year 2006 in Table 3.8 ($23,750,301) was 10.0% of the

Table 3.8: Fishing Contribution to GDP in 2006 and 2007 Using an Alternative Approach ($)

Harvest Sector	Gross Value of Production 2006	Gross Value of Production 2007	Value-Added Ratio	Value Added 2006	Value Added 2007
Coastal commercial	7,560,000	7,560,000	0.75	5,670,000	5,670,000
Coastal subsistence	15,732,000	15,732,000	0.85	13,372,200	13,372,200
Offshore locally based longline	3,461,922	8,366,856	0.20	692,384	1,673,371
Offshore locally based purse seine	7,928,233	15,541,521	0.50	3,964,117	7,770,761
Freshwater	8,000	8,000	0.95	7,600	7,600
Aquaculture	80,000	80,000	0.55	44,000	44,000
Total				**23,750,301**	**28,537,932**

GDP = gross domestic product.

Source: Consultant's estimates.

GDP of $236.9 million in FY2006. The total value added from fishing in calendar year 2007 was 14.4% of the projected GDP of $197.5 million in FY2007.

Although information on fisheries production is available through calendar year 2007 (Table 3.7), the latest year for which the FSM GDP is available is FY2006. As mentioned above, due to lack of precision for the estimates of production from coastal commercial and coastal subsistence fisheries, those estimates are almost equally applicable for 2006 and are used in Table 3.8. For locally based offshore fishing, the gross values of production from 2006 and 2007 (Table 3.4) are used.

It is not intended that the approach in Table 3.8 replace the official methodology, but rather the results obtained can serve as comparator to gain additional information on the appropriateness and accuracy of the official methodology—and possibly a need for modification.

Export of Fishery Products

Fishery exports were reported in Statistics Division (2008b). Some of the fisheries-related issues raised in the document were as follows:

- There is no existing requirement in the FSM for exporters to complete an exports declaration form to Customs. Therefore, the Division of Statistics uses an estimated number from other data sources.

- Data sources for offshore fish exports are the National Oceanic Resource Management Authority (NORMA), the National Fisheries Corporation, and staff estimates.[12] Data sources for inshore fish exports are quarantine records and Continental Airlines freight records for Chuuk State.
- The policy for inclusion/exclusion in fish exports is that fish should be included in exports if the company exporting is considered part of the FSM economy. Fish should also be included in exports if they undergo processing in the FSM. Fish should not be included if they are caught in FSM waters but do not have any other connection with the FSM economy aside from paying a license fee.
- In practice, the available data sources require some compromises because of the variety of arrangements for individual ships and companies and the difficulty in examining each of these in detail. The FSM Division of Statistics has decided to present fish exports as follows:

Longline catches:

1. Domestic vessels—included in exports
2. Domestic-based foreign vessels—included in exports
3. Foreign license—excluded from exports but included separately for information purposes

Purse seine catches:

1. Domestic vessels—included in exports
2. Domestic-based foreign vessels—included in exports
3. Foreign license—not presented because, apart from license fees, these do not contribute to the FSM economy

With the above guidelines in mind, the Statistics Division has compiled FSM exports for recent years. The marine product exports and a summary of nonmarine exports are given in Table 3.9, which indicates that in 2003–2007, marine products represented 70%–94% of all exports from FSM, the latest value, 2007, being 76%.

While Table 3.9 and the source document (Statistics Division 2008b) represent tremendous progress in monitoring exports, there is room for further improvement. For example, in 2006 and in 2007, there were definitely exports from longliners based in FSM, as indicated by NORMA staff (E. Pangelinan, personal communication, October 2008) and Table 3.8.

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12 One of the most experienced offshore fisheries specialists in Micronesia joined the Statistics Division in 2007.

Table 3.9: Marine and Nonmarine Exports of Federated States of Micronesia

Product		2003	2004	2005	2006	2007
Marine products						
Offshore fish						
purse seiner (domestic)	Weight (kg)	470,009	10,821,634	12,332,619	5,848,499	7,535,195
	Value ($)	2,368,895	7,206,011	9,670,269	5,465,828	11,155,265
purse seiner (domestic-based foreign)	Weight (kg)	211,259	0	0	0	0
	Value ($)	1,064,767	0	0	0	0
longliner (domestic)	Weight (kg)	8,528,891	1,832,053	364,300	0	0
	Value ($)	7,957,251	2,070,220	1,417,127	0	0
longliner (domestic-based foreign)	Weight (kg)	3,236,000	823,468	152,000	0	0
	Value ($)	1,947,816	930,519	591,280	0	0
Reef fish	Weight (kg)	214,335	16,273	152,159	5,630	244,241
	Value ($)	733,022	55,650	520,382	241,421	841,376
Crab/lobsters	Weight (kg)	6,142	3,651	6,311	2,193	6,887
	Value ($)	41,442	25,369	45,362	19,831	39,163
Trochus shell	Weight (kg)	0	0	0	135,100	23,714
	Value ($)	0	0	0	430,970	78,255
Live clams	Weight (kg)				2,474	4,281
	Value ($)				17,349	29,780
Other Marine Products	Weight (kg)	0	52	58	14,553	22,723
	Value ($)	0	90	225	38,506	157,480
Total marine products	Weight (kg)	12,666,636 12,668,639	13,497,131 13,499,135	13,007,447 13,009,452	6,008,449 6,010,455	7,837,039 7,837,041
	Value ($)	14,113,193	10,287,859	12,244,645	6,213,906 6,213,905	12,301,318 12,301,319
Nonmarine products						
Total agriculture products	Weight (kg)	461,352	963,401	344,547	445,365	319,576
	Value ($)	919,099	788,890	611,865	2,273,678	2,791,431
Total all others	Weight (kg)	3,158	9,758	17,800	39,531	4,124,752
	Value ($)	3,174,077	2,925,854	127,925	434,756	1,096,892
Total	**Weight (kg)**	**13,131,146 13,133,149**	**14,470,290 14,472,294**	**13,369,794 13,371,799**	**6,493,345 6,495,351**	**12,281,368 12,281,368**
	Value ($)	**18,206,369**	**14,002,603**	**12,984,435**	**8,922,341 8,922,399**	**16,189,640 16,189,642**

kg = kilogram.

Source: Statistics Division (2008b).

Fish exports were reported to be an average of 93% of FSM's recent annual exports of $20 million (IMF 2006).

Government Revenue from Fisheries

Access Fees for Foreign Fishing

FSM, through NORMA, licenses foreign vessels to fish for tuna in its EEZ. In 2007, the foreign licensed fleet included 104 longliners, 8 pole-and-line vessels, and 158 purse seiners (NORMA 2008). The access fees for this foreign fishing activity and their relative importance as a revenue source are given in Table 3.10.

Table 3.10 shows that about 10% of total revenue and grants of the Government of FSM come from fishing access fees. The $14.8 million in access fees for 2007 represents about $134 dollars for each of the 109,999 residents of the country in 2007.

Other Government Revenue from Fisheries

The NORMA annual reports do not provide information on government revenue other than fishing access fees. Apart from these fees, the governments of other Pacific island countries receive various types of revenue from the

Table 3.10: Access Revenue and Total Revenue and Grants ($)

Year	Fishing Access Revenue	Total Revenue and Grants of Government	Percentage Access Revenue to Total Revenue and Grants
1999	14,270,097	149,400,000	9.6
2000	15,671,779	148,800,000	10.5
2001	13,443,126	141,100,000	9.5
2002	9,177,660	160,300,000	5.7
2003	12,512,425	170,400,000	7.3
2004	12,697,369	133,600,000	9.5
2005	12,753,806	135,900,000	9.4
2006	13,753,956	139,700,000	9.8
2007	14,757,221	145,200,000	10.2

Sources: Access fees 1999–2006 are from National Oceanic Resource Management Authority's (NORMA) unpublished data; access fees for 2007 and government revenue are from the Statistics Division (2008c).

fisheries sector, including fish transshipment charges and export levies on fishery products. No information is available on the amount of such revenue in FSM, if any. Any licensing of small-scale fishing would occur at the state level.

Employment

The 2000 census gives some insight into employment in FSM. Of all positions in 2002, 37% were in government, 17% in retail/wholesale, 6% in manufacturing, and 5% in transport. The three productive sectors of the FSM economy (agriculture, tourism, and fisheries) provided little formal employment. Of the 15,712 people employed in the FSM as wage earners in 2002, only about 1,000 were employed in these three sectors (Division of Statistics 2004).

Numbers of people in FSM employed in "fishing" in recent years are given in Table 3.11 (Statistics Division 2008c). From the sources of information (FSM Social Security Administration records, government payroll) it appears that the survey was confined, or at least oriented, to formal employment with the larger fishing companies.

The Statistics Division (2008) survey also indicated that 109 people in Pohnpei during FY2006 were employed in fishing. The fisheries study carried out in Pohnpei between January 2006 and January 2007 indicated that there were 756 small-scale commercial fishers in Pohnpei at that time (Rhodes et al. 2007). DEA (2002) mentioned 275 active full-time fishers in Chuuk in

Table 3.11: Fishing Employment in the Federated States of Micronesia

Item	FY 2006	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007 Estimate
Number of employed persons, total	16,579	16,668	16,869	16,551	16,405	16,225	16,463	16,126
Number of employed persons in fishing	300	231	180	193	189	154	132	215
Percentage of employed in fishing	1.8	1.4	1.1	1.2	1.2	0.9	0.8	1.3

FY = fiscal year.

Source: Statistics Division (2008c).

Table 3.12: Employment in the Tuna Fisheries of Federated States of Micronesia

Item	2002	2006	2008
Local jobs on vessels	89	36	25
Local jobs in shore facilities	131	24	140
Total	**220**	**60**	**165**

Source: Gillett (2008).

2002, whereas Statistics Division (2008c) gave the fishing employment in that year in Chuuk as two people.

The number of jobs related to tuna fisheries (fishing and postharvest) over 7 years is shown in Table 3.12.

There has been limited attention to quantifying gender participation in fisheries in FSM. In 2000 and 2001, at the request of the Government of FSM, baseline surveys were conducted in Chuuk, Kosrae, Pohnpei, and Yap, assessing the role of women in the fisheries sector, opportunities and constraints to their development, and areas for assistance (Lambeth and Abraham 2001). Although some valuable ideas were put forward, little quantitative information was produced on the participation of women in fisheries.

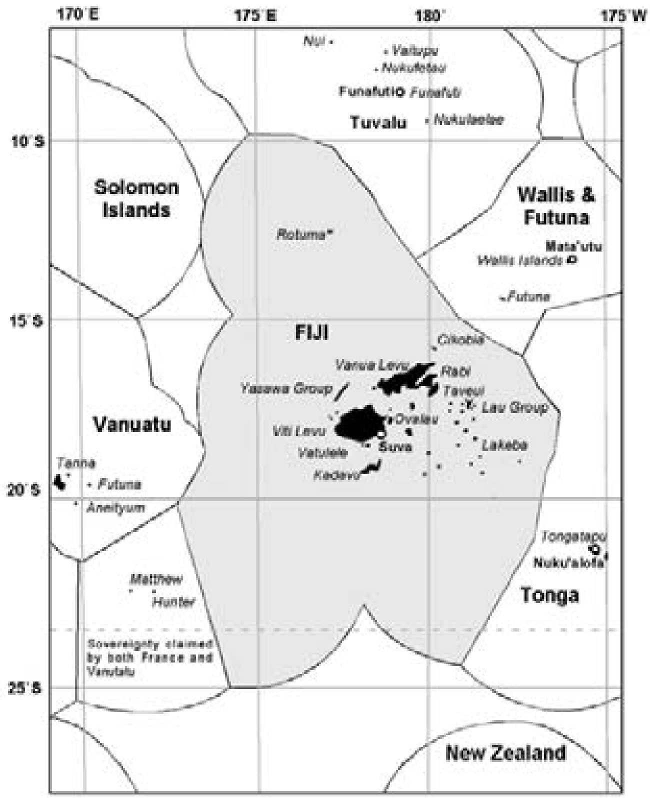
Fish Consumption

The 1998 HIES indicated a retail expenditure of $4,429,000 on canned fish, or about 27 kg of whole weight of fish per capita per year (the report of the 2005 HIES does not give expenditure on canned fish).

Annual per capita fish consumption in FSM in 1995 was estimated at 72 kg, based on FAO production, import, and export data (Preston 2000). Per capita fish consumption in late 1990s was estimated at about 87 kg per year, based on the above estimate and other factors (Gillett and Lightfoot 2001). Using the same approach, an estimate for 2007 is 114 kg. To this figure must be added any fish leakage from the tuna transshipment operations. Applying the 27.0 kg of canned fish from the earlier HIES to the 2007 production figures results in a per capita consumption of 142 kg.

For the whole FSM, annual per capita fish consumption (whole weight equivalent) in 2005, based on information from the HIES conducted that year, was 69.3 kg, of which 92% was fresh fish. For rural areas, per capita consumption of fish was 76.8 kg, and for urban areas, 67.3 kg (Bell et al. 2009).

Fiji Islands



Source: Secretariat of the Pacific Community.

Fish Production

Coastal Commercial Catches

Several estimates of the magnitude of coastal commercial fisheries are given in government documentation. The total quantity of seafood retailed through domestic markets in 2004 was 10,969 t, with a value of F$44,903,587 (DOF 2005). A comment was made that this had increased 82% over the previous year, likely due to an enhanced data collection system.

The "artisanal catch" in 2005 was about 5,994 t of reef fish (67%) and invertebrates (33%). The value of these landings, as estimated from the market prices, was approximately F$27 million (DOF 2008a). In 2006, production was about 4,922 t of finfish worth F$28.6 million and non-finfish valued at F$18 million (DOF 2008b).

A study in 2008 by researchers from the University of British Columbia estimated the catch of "reef-based artisanal fisheries" by considering past estimates and by undertaking original research, and indicated an annual catch of reef-associated finfish and invertebrates of 7,743 t, with a final market value of $33.4 million (F$53.4 million) (Starkhouse 2009). However, that study did not consider exports. Including pelagic fish caught by coastal commercial fishers, about 8% more finfish should be added in both quantity and value.

The total also needs to include exported trochus (raw shells and button blanks), bêche de mer, aquarium products, and coral. It is not possible to use Customs Department export data to determine the quantities of such exports because the classification system used does not always discriminate between exports from coastal commercial fishing and exports from offshore fishing or from aquaculture. For example, the category "other fish fresh or chilled" could easily be a mixture of tuna and inshore species.

Annual coastal commercial fishery production in the Fiji Islands in late 1990s was about 9,320 t valued at F$30 million (Gillett and Lightfoot 2001).

Principal exports from coastal fisheries in 2003 were marine aquarium products (F$14 million annually), bêche de mer (F$8.6 million), trochus (F$1.7 million), deepwater snapper (F$250,000), and live reef food fish (F$450,000), a total of about F$24.5 million per year (ADB 2005),[13] which, using a semi-arbitrary value of F$20/kg, equated to 1,225 t of exported products. DOF (2008a) gives a value of inshore resources exported in 2005 of about F$31.7 million.

It should be noted that the above information includes a mixture of prices paid to fishers, retail market prices, and export prices. Discounting retail and FOB export prices by 30% to approximate prices paid to fishers would result in a standard catch value that is more comparable. Selectively using the above information and adjusting prices, the 2007 coastal commercial catch was 9,500 t worth about F$54 million to the fishers.

Coastal Subsistence Catches

Annual subsistence catches in early 1990s were estimated at 16,600 t worth $45.8 million (Dalzell et al. 1996); a value of F$50 million according to

13 These are apparently free on board (FOB) values.

"recent surveys" (Anon 2001a); and about 21,600 t worth F$48.6 million in late 1990s (Gillett and Lightfoot 2001).

Subsistence fishery harvests were 18,000 t in 2000; 18,200 t in 2001; 18,400 t in 2002; 18,600 t in 2003; and 18,800 t in 2004 (DOF 2005). The 2006 annual report (DOF 2008b) adds the comment "A current measure of the effort in the subsistence fisheries is not available as the Department is not monitoring this fishery due to restricted available resources."

However, the DOF estimates were based on a 1979 small-scale fishing survey that covered only Viti Levu and used a single respondent in each village to recall landings over the previous 12 months (G. Preston, personal communication, August 2001). For the past 28 years, the estimate of small-scale production (the largest component of the domestic catch) for all the Fiji Islands has been made simply by adding 200 t of fish annually to the questionable 1979 figure. The results of a small-scale fisheries survey in 1993 (Rawlinson et al. 1993) were not used to modify the 1979 estimate. Similarly, the results of a 1995 survey of the Northern District were not written up or used to modify the 1979 estimate. The Rawlinson survey suggested that the small-scale commercial catches in Viti Levu were larger than those estimated by the statistical system.

In 2008, the mean annual subsistence catch (± standard error) was estimated through a substantial survey at 17,407 t (± 55 t), consisting of a mean finfish catch of 11,840 t (± 39 t), and mean invertebrate catch of 5,461 t (± 19 t). Gross value was estimated at $35.8 million ± 0.1 million (F$54.1 million ± 0.15 million) (Starkhouse 2009). These catch estimates are lower than the official estimate. The researcher felt that this is due to the inadequacies of the 1979 survey and that the practice of adding 200 t each year is flawed, given recent temporal and spatial population growth patterns (B. Starkhouse, personal communication, August 2008).

Locally Based Offshore Catches

Estimates of the quantities and values of catches of the four main commercial species of tuna in the Western and Central Pacific Fisheries Commission (WCPFC) area were made by the Forum Fisheries Agency (FFA) using data from the Oceanic Fisheries Programme of the Secretariat of the Pacific Community (SPC). Catches by the "Fiji national fleet" are given in Table 4.1 In the table, prices are all "delivered" prices, the prices received at entry to the country in which they are usually sold whether for processing or consumption; for yellowfin and bigeye tuna, it is assumed that 80% of the catch is of export quality and 20% is nonexport quality. For export quality,

Table 4.1: Tuna Catches by the Fiji Islands National Tuna Fleet

Item	1999	2000	2001	2002	2003	2004	2005	2006	2007
Catch (ton)	4,071	9,651	11,312	11,558	10,856	17,298	11,966	15,372	10,749
Delivered value ($ million)	12.69	35.45	36.81	31.71	34.61	60.89	38.47	52.35	34.46
Delivered value (F$ million)	25.13	75.51	85.77	68.18	64.03	105.34	65.40	91.61	55.14

F$ = Fiji dollar.

Source: Forum Fisheries Agency (2008).

Table 4.2: Total Catch by the Locally Based Offshore Fleet in the Fiji Islands (t)

Year	Albacore	Bigeye	Yellowfin	Total Tuna	Bycatch
2003	6,881	889	2,482	10,252	2,062
2004	11,290	1,254	4,164	16,708	5,579
2005	8,901	423	1,989	11,313	4,182
2006	11,802	771	2,231	14,804	5,903
2007	7,145	556	1,721	9,422	2,995

t = ton.

Source: Amoe (2008).

Japanese fresh yellowfin and bigeye import prices from Oceania are used, while nonexport grade tuna is given an assumed value of $1.50/kg. Table 4.1 also excludes bycatch, although it is an important component of locally based offshore fisheries.

Table 4.2 gives catches of tuna and bycatch for the "domestic longline fleet." Because there has not been any locally based pole-and-line fishing in recent years, this is equivalent to the locally based longline fleet.

For the locally based offshore catch of 12,205 t (tuna and bycatch) in 2003, it is estimated that 42% of catch was sold to canneries (average ex-vessel price of F$3,547), 37% was fresh exports (average price/t of F$6,207), and 21% was domestic sales (average price/t of F$2,200 for tuna and F$2,000 for bycatch) (ADB 2005). This gives a total value of catch of F$49.5 million ($26.6 million) for 2003 for the offshore fleet. This information is useful for estimating the dockside value of the entire catch (tuna plus bycatch) for more recent years. It suggests that the "delivered value" of tuna in Table 4.2 should be (i) reduced by 25% to obtain dockside tuna values, and (ii) increased by 10% to account for the sale of bycatch.

Foreign-Based Offshore Catches

In recent years, the amount of foreign fishing activity has been quite small and has consisted exclusively of pole-and-line fishing by Japanese vessels and sporadic purse seine fishing by Japanese and US vessels.[14] If the price for these fish in the destination markets was $1,200/t, the value in the Fiji Islands waters was around $1,070/t. The total annual value of the tuna catch in the Fiji Islands waters in recent years is therefore estimated to have ranged between F$0.15 million and F$2.91 million (Table 4.3).

Table 4.3: Estimating Tuna Catches in Fiji Islands Waters by Foreign-Based Fleets

Tuna Catch	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total catch of all fleets in the Fiji Islands waters (t)[a]	5,064	8,742	10,807	9,437	7,328	9,819	6,005	7,422	6,469
Catch of Fiji Islands fleet in the Fiji Islands waters (t)[a]	3,688	7,619	10,387	9,342	7,022	9,043	5,525	7,341	5,976
Catch of foreign fleet in Fiji Islands waters (t)[a]	1,376	1,123	420	95	306	775	481	81	492
Value of foreign fleet catch in Fiji Islands waters ($)[b]	1,472,320	1,201,610	449,400	101,650	327,420	829,250	514,670	86,670	526,440
Value of foreign fleet catch in Fiji Islands waters (F$)[b]	2,915,194	2,559,612	1,045,846	218,626	606,446	1,433,834	872,823	149,702	843,564

F$ = Fiji dollar, t = ton.

[a] Source: Forum Fisheries Agency (2008).

[b] Consultant's estimates.

Freshwater Catches

Harvests of freshwater finfish and invertebrates in the Fiji Islands consist mainly of freshwater clams (*Batissa violacea*), eels, various freshwater crustaceans, and

[14] In 2007, the only foreign-based offshore fishing activity was by the US purse seine fleet (A. Raiwalu, personal communication, November 2008).

introduced fish, such as tilapia and carps. There is no consolidated accounting of the catches of these species. The Fisheries Department staff indicate that the harvest of clams/crustaceans for nonmarket purposes is probably less than what is marketed.

Annual market sales of *Batissa* clams were 1,000–1,800 t in 1986–1992 (Richards 1994). Flagtails (*Kulia* species) and a number of goby species were important for interior villages, but their abundance decreased "in recent years" (Thaman 1990). Richards (1994) observed that there was not a strong local preference for freshwater eels and no organized fishery for them, but later, Nandlal (2005b) reported that they were an important source of protein for the rural population.

The most recent data are for 2004, when 2,526 t of *Batissa*[15] worth about F$2.2 million and 500 t of crustaceans valued at about F$6 million were sold in municipal and nonmunicipal markets (DOF 2005).

Aquaculture Production

Annual aquaculture production in 2003, based on recent literature, was estimated to total 400 t and 28,420 pieces worth F$1.87 million (ADB 2005) (Table 4.4).

Other information on recent aquaculture production in Fiji Islands includes the following:

- ADB (2005) stated that "at the height of the Fiji Islands seaweed industry in 2000, 658 farms had been established in 47 villages/

Table 4.4: Fiji Islands Aquaculture Production, 2003

Category	Amount (weight/pieces)	Value (F$)
Brackishwater shrimp	850 kg	25,380
Tilapia	393,000 kg	1,572,000
Carps	160 kg	626
Prawns	6,000 kg	108,000
Fancy carps	17,000 pieces	68,000
Goldfish	10,420 pieces	41,680
Black pearls	1,000 pieces	50,000
Total	400 tons + 28,420 pieces	F$1,865,686

Source: Asian Development Bank (2005).

15 This includes the shell weight. Raw meat recovery is approximately 20%.

settlements around the coast and maritime zone with an average annual production of 300 million tons (mt) valued at F$275,000. Since its inception in 1998, Government has spent over F$1.8 million in direct assistance to seaweed farmers[16] with total production of 1,413.8 mt and an export value of F$1.5 million. In other words, the total value of exports was less than the subsidy." Production was 24 t in 2003 and 48 t in 2004.

- Information on the freshwater aquaculture pond census of 2004 was given in SPC (2004). Nile tilapia (*Oreochromus niloticus*) and giant freshwater prawn (*Macrobrachium rosenbergii*) were the two main commodities. Some 30 t of tilapia valued at $125,000 and 1.7 t of prawns worth $30,000 were produced.
- Unpublished data from the Fisheries Department ("Seaweed Production Figures") showed seaweed production in 2006 of 118 t worth F$59,025 and in 2007 of 60 t worth F$30,026.
- Unpublished data from the Fisheries Department ("Seeded Oyster Information 2007") showed 53,100 pearls harvested/sold in 2007.
- The operator of the largest pearl farmer in the Fiji Islands estimated a total pearl harvest of 48,100 pieces worth F$1,077,440 in 2007 (J. Hunter, personal communication, August 2008).
- The aquaculture section of the draft 2007 annual report (DOF 2008c) and senior staff of the Fisheries Department (M. Lagibalavu, personal communication, August 2008) indicated that in 2007, aquaculture production was 142.7 t of tilapia[17] worth F$712,300, 24.04 t of freshwater prawns (F$575,380), 13 t of brackishwater prawns (F$400,000), and 67 t of seaweed (F$33,500).[18]

16 There are reports that much of the money allocated by the government to assist seaweed farmers was not used for developing seaweed culture, but rather for political activities. Nevertheless, public funds were allocated and used in the name of supporting seaweed culture.

17 Fisheries Department officials confirm that the 142.7 t of tilapia includes production for subsistence purposes.

18 There are reports of the culture of live-rock and coral in the Fiji Islands in 2007 and 2008 (T. Pickering, SPC personal communication February 2009), but the Fisheries Department's aquaculture report for 2007 has no information on quantities produced. Subsequent discussions with a Fiji Islands coral specialist (E. Lovell, personal communication, April 2009) indicate that the culture of these two products is still in its infancy.

Summary of Harvests

A crude approximation of the Fiji Islands' annual production and value[19] in 2007 was made (Table 4.5) by selectively using the above information. The extremely weak factual basis for the estimate of the freshwater catch is acknowledged.

Table 4.5: Annual Fisheries and Aquaculture Harvest in the Fiji Islands, 2007

Harvest Sector	Quantity (t)	Value (F$)
Coastal commercial	9,500	54,000,000
Coastal subsistence	17,400	54,100,000
Offshore locally based	13,744	46,870,000
Offshore foreign-based	492	844,000
Freshwater	4,146	6,860,000
Aquaculture	48,100 pieces plus 247 t	2,799,000
Total	**48,100 pieces plus 45,529 t**	**165,473,000**

F$ = Fiji dollar, t = ton.

Source: Tables above and author's estimate.

Contribution of Fishing to GDP

Current Official Contribution

The Fiji Islands' GDP at current market prices and the contribution of fishing are shown in Table 4.6 (FIBOS 2008).

Method Used to Calculate the Official Fishing Contribution to GDP

The methods currently used by the Fiji Islands Bureau of Statistics (FIBOS) to calculate the fishing contribution to GDP are those given in A Study of the Agriculture, Forestry, and Fishing Sector 2002 (FIBOS 2007):

19 The values in the table are dockside and/or farm-gate prices, except in the case of offshore foreign-based fishing where the value in Fiji Islands waters (overseas market prices less imputed transshipment costs) is given.

Table 4.6: Official Contribution of Fishing to GDP (F$'000)

Item	2000	2001	2002	2003	2004	2005	2006	2007
GDP (current market prices)	3,584,753	3,777,204	4,026,442	4,382,661	4,719,513	4,969,692	5,455,711	5,263,607
Fishing								
Commercial	70,160	52,649	65,542	43,035	66,682	79,597	70,205	61,920
Subsistence	33,877	33,906	35,986	35,328	38,162	42,054	40,162	38,354
Public sector[a]	1,150	639	484	1,197	1,248	1,273	1,238	1,524
Fishing contribution to GDP								
By value	105,187	87,194	102,013	79,561	106,092	122,924	111,604	101,799
By share (%)	2.9	2.3	2.5	1.8	2.2	2.5	2.0	1.9

F$ = Fiji dollar, GDP = gross domestic product.

[a] Commercial fisheries activities of the Fisheries Department.

Source: Fiji Islands Bureau of Statistics (FIBOS) (2008); 2007 figures are provisional.

- The fisheries sector is divided into six subsectors: (1) fishing on a commercial basis, (2) taking of marine or freshwater crustaceans and mollusks, (3) sea cucumber diving, (4) operation of fisheries hatcheries and farms, (5) seaweed farming, and (6) aquarium fish and corals.
- For each subsector, information on the gross value of production is obtained from the Fisheries Department.
- From surveys conducted by FIBOS, intermediate consumption and valued added are determined. The value added is converted to a VAR.
- The VAR is multiplied by the gross output for each subsector to determine the value added by the fishing sector.
- According to FIBOS staff, "public sector" is the commercial fisheries activities of the Fisheries Department (M. Navilini, personal communication, January 2009).

Following are comments on calculating the fishing contribution to GDP in the Fiji Islands. These comments are not intended to be authoritative, but rather are aimed at providing some fisheries insight that may be of value to statisticians involved in national accounting and who may be unfamiliar with the fishing sector.

- The VARs determined by FIBOS surveys seem quite small: commercial fishing (10.2%), taking of crustaceans or mollusks (28.6%), bêche de mer diving (10.2%), fish farms (45.0%), seaweed farming (30.3%), and aquarium fish and corals (29.3%). Gillett and Lightfoot (2001) used much larger VARs. For example, a VAR of 90% was used for nonmotorized subsistence fishing, more than three times the VAR used by FIBOS for crustaceans or mollusks.
- The gross output of production (supplied by the Fisheries Department) for some subsectors seems too large, or even erroneous. For example, for 2002, FIBOS uses a gross production of F$153 million for offshore fishing and F$12 million for aquaculture. However, for 2003, the ADB fisheries sector study (ADB 2005) estimated the gross value of production of offshore fishing at F$49 million and of aquaculture at F$1.9 million.
- The six subsectors chosen to partition the fishing sector may be inappropriate. This is due to (i) lumping dissimilar fisheries (e.g., combining “inshore non-fin” with “live reef food”) and (ii) excluding some categories of fishing (e.g., subsistence fishing for finfish).

Alternative Estimate of Fishing Contribution to GDP

Table 4.7 is an alternative to the official method of estimating fishing contribution to GDP in the Fiji Islands. It is a simple production approach that takes the values of five types of fishing and aquaculture activities for which production values were determined and summarized in Table 4.5 above. This approach also determines the value added by using VARs characteristic of the type of fishing concerned. The VARs were determined by knowledge of the fisheries sector and use of specialized studies (Appendix 3).

The approach in Table 4.7 is not intended to replace the official methodology, but rather the results obtained can serve as a comparator to gain additional information on the appropriateness and accuracy of the official methodology—and possibly to point a need for modification.

The total value added in Table 4.7 (F$89.9 million) is about 12% less than the official value added of F$101.8 million. The major difference is that the contribution from the official “fishing” (F$61.9 million) is greater than the combined contribution of “coastal commercial” and “offshore locally based” of the alternative estimate (F$34.9 million).

Table 4.7: Fishing Contribution to Fiji Islands' GDP, 2007, using an Alternative Approach

Harvest Sector	Value (F$) (From Table 4.5)	Value-Added Ratio	Value Added (F$)
Coastal commercial	54,000,000	0.55	29,700,000
Coastal subsistence	54,100,000	0.80	43,280,000
Offshore locally based	46,870,000	0.20	9,374,000
Freshwater	6,860,000	0.90	6,174,000
Aquaculture	2,799,000	0.50	1,399,500
Total	**164,629,000**		**89,927,500**

F$ = Fiji dollar.

Source: Consultant's estimates.

Table 4.8: Fishery Exports of the Fiji Islands, 1999–2007

Year	Value of Fishery Exports (F$'000)	Value of All Fiji Islands' Exports (F$'000)	Fishery Exports Share in Total Exports (%)
1999	57.5	947.6	6.1
2000	70.5	996.0	7.1
2001	91.2	990.7	9.2
2002	78.4	847.1	9.3
2003	79.4	958.3	8.3
2004	81.4	950.7	8.6
2005	82.9	847.6	9.8
2006	97.9	834.3	11.7
2007	101.3	828.8	12.2

F$ = Fiji dollar.

Source: Reserve Bank of Fiji Islands (2008) citing the Fiji Islands Bureau of Statistics.

Export of Fishery Products

The relative importance of fishery exports doubled during 1999–2007, as shown in Table 4.8.

The Fisheries Department annual reports contain detailed export data. This information is obtained by the Fiji Islands Bureau of Statistics from data collected by the Fiji Islands Revenue and Customs Authority. A list of the 2007 fishery exports is given in Table 4.9.

Table 4.9 highlights the importance of tuna exports for the country; almost all the products at the top of the table are tuna. It also indicates the

Table 4.9: Export of Fishery Products in 2007

Product Description	Quantity (kg)	Value (F$)
Total	**28,282,006**	**94,399,383**
Albacore or long-finned tunas, frozen	10,202,994	18,087,434
Albacore or long-finned tunas, fresh or chilled	5,226,787	14,645,891
Other tunas, frozen	2,871,737	13,490,381
Other tunas, fresh or chilled	2,446,529	7,520,291
Others	474,582	6,582,355
Yellowfin tunas, frozen	1,284,192	5,868,099
Other fish, frozen	849,405	5,675,145
Yellowfin tunas, fresh or chilled	1,056,207	4,816,845
Other fish including fillets, smoked	45,940	4,604,198
Other fish meat and fish fillet	208,880	1,327,059
Bigeye tuna, frozen	332,025	1,036,498
Octopus	66,100	1,000,602
Other dried fish, salted or not, but not smoked	15,315	933,933
Live ornamental fish	116,805	878,246
Other fish, whole or in pieces prepared/preserved	354,587	854,277
Fish fillet, fresh or chilled	167,764	848,393
Other fish, fresh or chilled	39,843	794,842
Other fish, salted in brine	78,356	755,838
Flours, meals, and pellets of fish, crustaceans, mollusks; and other aquatic invertebrates	866,000	633,124
Tuna, skipjack, and bonito, whole or in pieces	146,243	607,483
Other crustaceans	12,531	492,089
Bigeye tuna, fresh or chilled	196,725	467,466
Button moulds/blanks of pearl or trochus	34,254	427,424
Other mussels frozen, dried	220,258	268,590
Other scallops frozen, dried	43,082	240,629
Other live fish	62,163	232,717
Pearls, cultured unworked	54	228,796
Dogfish and other sharks, frozen	71,860	221,559
Frozen fillets	41,916	136,949
Squid	1,838	125,583
Mackerel tuna, whole or in pieces prepared/ preserved	38,709	118,420

continued on next page

Table 4.9: continuation

Product Description	Quantity (kg)	Value (F$)
Dogfish and other sharks, fresh or chilled	111,151	118,270
Flours, meals, and pellets of fish/crustaceans/ invertebrates	503,000	73,663
Other prepared or preserved fish	20,070	64,240
Cuttlefish live, fresh or chilled	5,882	63,738
Fish fillets, dried salted or in brine, not smoked	1,760	52,800
Products of fish or aquatic invertebrates	23,433	47,690
Seaweed and other algae for human consumption	40,907	32,405
Other mollusks and invertebrates, prepared/ preserved	1,074	10,740
Shrimps and prawns, frozen	180	4,638
Shrimps and prawns, prepared or preserved	150	4,213
Sardines, whole or in pieces, prepared/preserved	264	2,896
Skipjack or stripe-bellied bonito, frozen	150	900
Mackerel, frozen	83	830
Crabs, frozen	124	558
Scallops live, fresh or chilled	30	513
Sardines	70	133

F$ = Fiji dollar, kg = kilogram.

Source: Fiji Islands Bureau of Statistics (FIBOS), unpublished data.

importance of "live ornamental fish" (likely to be real) and "octopus" (likely to be a classification error).

The difference in the total export values for 2007 in the two tables in this section is likely to be because of doubt over whether some items (e.g., coral and similar material) are "fishery product."

An overall appreciation of what commodities are being shipped abroad can be obscured by the use of Standard International Trade Classification categories (column one of Table 4.9) and by errors made by exporters in placing exports in those categories. ADB (2005) clarified the Fiji Islands' fishery exports for 2003: "Total sector exports are F$79 million consisting predominately of tuna exports (F$49 million). The other principal exports are marine aquarium (F$14 million), bêche de mer (F$8.6 million), trochus (F$1.7 million), deepwater snapper (F$250,000), and live reef food fish (F$450,000)."

Government Revenue from Fisheries

Access Fees for Foreign Fishing

In recent years, the only foreign-based vessels that have been licensed to fish in the Fiji Islands waters are those from Japan and the US. The Fiji Islands received JP¥1,800,000 for access by six vessels in 2006 (DOF 2008b). According to the senior licensing official of the Fisheries Department, for political reasons, no payments were received from Japan in 2007 (A. Raiwalui, personal communication, November 2008).

The situation regarding access by US vessels is more complex. Under the terms of the US multilateral tuna treaty, the Fiji Islands and other Pacific island countries receive payments from the Government of the US and the US tuna industry that are associated with fishing access by US purse seiners. For June 2005–June 2006, payments to the Fiji Islands totaled $393,919 (NMFS unpublished data). For June 2006 to June 2007, due to political reasons, the Government of the US could not make access payments to the Government of the Fiji Islands, but increased US industry contributions were made—estimated to be $256,985. Table 4.10 summarizes the fishing access payments.

The Fiji Islands' "total revenue" in the "Revised 2007 Budget" was given at almost F$1.5 billion (Ministry of Finance and National Planning 2007). The F$411,176 in access fees, therefore, represented about 0.03% of total revenue for the year.

Table 4.10: Fiji Islands Access Fees, 2006 and 2007

Country	2006 (F$)	2007 (F$)
Japan	27,054	0
United States	681,479	411,176
Total	**708,533**	**411,176**

F$ = Fiji dollar.

Sources: Department of Fisheries (2008c) and National Marine Fisheries Service (of the United States), unpublished data.

Other Government Revenue from Fisheries

Fees paid by the locally based offshore fishing fleet in 2005 and 2006 are given in DOF (2008a, 2008b) (Table 4.11). Domestic license fees are divided

Table 4.11: Fees Paid by the Locally Based Offshore Fishing Fleet (F$)

Year	Access Fee	Management Fee	Other License Fees	Total
2005	515,000	408,000	880	923,880
2006	525,000	432,000	660	957,660

F$ = Fiji dollar.

Sources: Department of Fisheries (2008a, 2008b).

Table 4.12: Fees from Coastal Commercial Fishing, 2006

Fee Type	Value (F$)
Fishing license	9,109
Lautoka fishing port fees	8,215
Vessel registration	5,961
Issuance of CITES export permits	25,365
Total	**48,650**

CITES = Convention on International Trade in Endangered Species, F$ = Fiji dollar.

Source: Department of Fisheries (2008b).

into a management fee, paid by all licensees, and an access fee, paid by all nonindigenous Fijian license-holders. The management fees largely support the Management Services Unit while the access fees go into consolidated revenue (Barclay and Cartwright 2006).

The government also collects fees from coastal commercial fishing activity. Table 4.12 shows the fees given in 2006 (DOF 2008b).

Employment

The Fiji Islands Bureau of Statistics carried out the "2004–2005 Employment and Unemployment Survey" (Narsey 2007). Unfortunately, the survey report provides limited insight into fisheries employment due to aggregating all agriculture, forestry, and fisheries occupations. It did, however, give the number of people in the Fiji Islands—150,982 wage/salary earners (38% of them female) and 91,818 self-employed (25% of them female). This is useful for gauging the relative importance of fisheries employment from the more specialized studies.

The most comprehensive review of fisheries-related employment in the Fiji Islands was in the ADB review of the fisheries sector (ADB 2005). The results are summarized in Table 4.13. Some of the important details are:

- There were an estimated 895 boats, mostly 5-meter skiffs, operating in the country's small-scale fisheries. Total number of crew in the artisanal fleet was 2,137, although many artisanal fishers had additional sources of income.
- Over 400 individuals were directly involved in tilapia farming, and an estimated 150 Fijians were employed in all other forms of aquaculture. Total employment in the sector was estimated at 550 with high levels of participation by villagers in many aspects of aquaculture.
- Total employment by fish processors was estimated at 1,394, including 800 permanent Pacific Fishing Company (PAFCO) employees. Based on a survey of operators conducted for this review, wages and salaries totaled an estimated F$8.9 million (including F$5.4 million in wages and salaries paid by PAFCO).
- The marine aquarium fishery consisted of five operators. The largest operator, Walt Smith International, exported more than 50% of the industry's total and employed 70 onshore staff and around 300 collectors and divers. Total employment of Fijians in collection/diving was estimated to be 650, with about 150 employed by marine aquarium companies in onshore roles.
- An estimated 20–30 commercial charter and sportfishing boats operate in the Fiji Islands, and with rapid growth in tourism (at the time of survey), the sector was enjoying an expansion phase. Employment was about 60 full-time equivalents.
- There were 16 municipal markets in Fiji Islands, 7 in the central division, 4 in the western division, and 5 in the northern division. It is estimated that 480 people were employed at the municipal markets, and given that markets operate for about half the week, this equated to 240 full-time equivalent jobs. Additional 36 dedicated fish retail outlets employed some 100 Fijians.

Although the ADB study is the most comprehensive assessment of fisheries employment in the Fiji Islands, other studies provide additional insight, as follows:

- There were 64,500 full-time, part-time, or occasional fishers in the Fiji Islands in 1994, according to a FAO estimate (Visser 1997).
- Some 15.2% of all households in the Fiji Islands in 2004 sold at least some of their catch and 29.6% of those earned more than F$50 per month, according to results of the 2004 the Fiji Islands National Nutrition Survey (NFNC 2007).

Table 4.13: ADB Estimate of Fisheries Employment in 2004

Category	Employment (full-time equivalents)
Offshore fishery	510
Inshore artisanal	2,137
Subsistence	3,000
Marine aquarium	650
Aquaculture	550
Game and charter fishing	60
Pacific Fishing Company	800
Other fish processors	639
Input suppliers	185
Fish markets	340
Department of Fisheries	243
Slipways, ports	30
Total	**9,144**

Source: Asian Development Bank (2005).

Table 4.14: Local Employment in the Tuna Industry

Item	2002	2006	2008
Local jobs on vessels	893	330	150
Local jobs in shore facilities	1,496	2,200	1,250
Total	**2,389**	**2,530**	**1,400**

Source: Gillett (2008).

- In 2005, the artisanal fishery consisted of 2,550 fishers with 1,114 boats (DOF 2008a).
- There were an estimated 827 females working in the tuna industry in 2007 (longline fishing companies and the tuna cannery), according to a study of gender issues in the Fiji Islands' tuna industry (Sullivan and Ram-Bidesi 2008).
- In 2008, the Fiji Islands' coral reef-based artisanal fisheries employed an estimated 4,447–10,152 fishers, 350–702 entrepreneurs, and 1,033–2,067 vendors; that is, a total of 5,897–12,921 individuals participating in the fisheries, including about 1,250 full-time fin-fishers (Starkhouse and Sumaila 2008).
- Local employment in tuna fishing in recent years is shown in Table 4.14.

Combining information in the ADB study (ADB 2005) and the Fiji Islands employment study (Narsey 2007), the estimated 9,144 fisheries jobs represent 3.8% of total jobs (wage, salaried, self-employed) in the Fiji Islands. Similarly, the study of gender issues in the Fiji Islands' tuna industry (Sullivan and Ram-Bidesi 2008) and the Fiji Islands employment study show that the jobs held by females in the Fiji Islands' tuna industry represent about 1.0% of total jobs held by females in the Fiji Islands. While there is considerable gender-specific information on employment in the Fiji Islands' tuna industry, there is little in the wider fisheries sector.

Fish Consumption

Seafood consumption per capita for 1995–1999, based on the official production data divided by the Fiji Islands population, is given in Table 4.15.

In 1995, the apparent per capita supply of fish in the Fiji Islands was 50.7 kg per year, according to FAO production, import, and export data (Preston 2000).

The 2004 Fiji Islands National Nutrition Survey (NFNC 2007) did not provide much insight on the level of seafood consumption. However, it showed that fresh fish was consumed daily by 23.4% of indigenous Fijian households, while canned fish was consumed daily by 8.3%. In Indo–Fijian households, only 2.4% reported eating fresh fish and 1.9% reported eating canned fish daily.

In recent years, the total annual catch from locally based offshore fisheries was about 15,000 t (section 4.1). About 12.5% of the production from locally based offshore fisheries was not exported but was marketed domestically

Table 4.15: Seafood Consumption Per Capita, 1986–1999

Year	Seafood Consumption (kg/capita/year)	Seafood from Subsistence Fishery %
1995	58.0	39
1996	62.0	37
1997	44.0	53
1998	47.0	51
1999	56.0	46

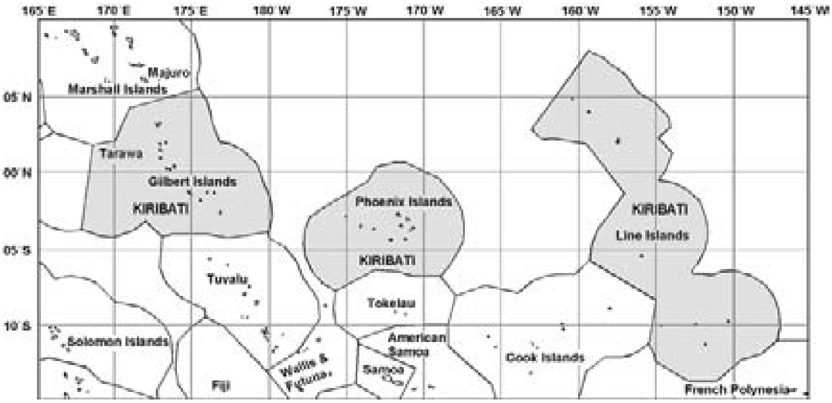
kg = kilogram.

Source: Fisheries Division (2000).

in the greater Suva area (R. Dunham, D. Lucas, personal communication, December 2008). Population of the greater Suva area is about 180,000 (Fiji Faqs 2008). These data suggest an annual supply of 10.4 kg per capita of fish to Suva residents from the local offshore fleet.

Per capita annual fish consumption (whole weight equivalent), based on the HIES in 2002 and 2003, was estimated at 15.0 kg (45% of this was fresh fish) per capita per year in urban areas and 25.3 kg (66% fresh fish) per capita per year in rural areas (Bell et al. 2009).

Kiribati



Source: Secretariat of the Pacific Community.

Fish Production

Coastal Commercial Catches

Annual coastal fisheries production in 1991 was estimated at 3,240 t worth $4.8 million (Dalzell et al. 1996). Gillett and Lightfoot (2001) considered the Dalzell estimate, studies by the Fisheries Division and other agencies, and the opinions of fisheries specialists with substantial experience in Kiribati, to estimate the coastal commercial fisheries production in late 1990s at 6,000 t worth $9.8 million.

Recent annual reports of the Fisheries Division (2003–2006) contained much valuable information, but the only attempt to consolidate overall fisheries production information appeared to be in the 2003 report: "The weekly fish production for all Islands in the Gilbert group is 489.5 t/week. This shows a decrease of 38% from last year's figure of 791.7 t/week" (Fisheries Division 2004).

Fishery production data for various years in the Kiribati islands are shown in Table 5.1.

Preston (2008) partitioned coastal fisheries production into two components: household fishery catch and export fishery catch. Based on information in Table 5.1, the annual total household fishery catch was 20,000 t. However, because the available export production statistics are

Table 5.1: Fishery Production Data in Kiribati, by Island

Island	Year Surveyed	Population During Survey Year	Fishing Households During Survey Year	Weekly Catch per Fishing Household (kg)	Annual Catch by Island (t)
Gilbert Islands					
Banaba	1999	339	60	32.8	95
Makin	1986	1,738	61	33.0	413
Butaritari	1992	3,742	651	44.0	1,375
Marakei	1998	2,842	361	34.0	594
Abaiang	1995	6,020	717	30.0	1,038
North Tarawa	1996	6,061	544	17.0	447
North Tarawa	2003	5,678	693		1,065
North Tarawa	2006	5,678	693		1,372
South Tarawa	1999	29,994	4,019	35.5	6,849
South Tarawa	2005	40,311	4,529		7,504
South Tarawa	2006	40,311	5,245		5,370
Maiana	1993	2,331	374	21.3	383
Abemama	1996	3,499	153	92.8	682
Kuria	1994	957	515	26.7	660
Aranuka	1994	1,095	158	33.1	251
Nonouti	1990	2,801	535	48.4	1,244
North Tabiteuea	1999	3,579	482	20.3	469
South Tabiteuea	1995	1,404	258	29.5	366
Beru	1998	2,190	295	34.5	488
Nikunau	1987	2,823	452	35.7	775
Onotoa	1992	1,839	455	35.1	768
Tamana	1998	1,233	215	36.9	381
Tamana	2002	875	214		719
Tamana	2006	875	916		781
Arorae	1998	1,284	225	29.1	314
Arorae	2001	1,256	244		709
Arorae	2006	1,256	275		596
Line Islands					
Tabuaeran	2000	1,733	241	40.1	926
Teraina	2000	1,409	167	140.0	1,121

kg = kilogram, t = ton.

Sources: Lovell et al. (2000); Preston (2008); Fisheries Division surveys; and the 2005 census.

Table 5.2: Available Information on Exports from Kiribati Coastal Fisheries

Item	2002	2003	2004	2005	2006	2007
Value (A$)						
Fish	27	12	84	426	585,000	1,244
Aquarium (pet) fish	2,500	311	694,639[a]		900,000[b]	
Shark fins	437	469			131,000	
Bêche de mer	454	254			216,000	220
Lobster					65,000[b]	
Quantity (t)						
Fish	3	1	0	189	663	2,362
Aquarium (pet) fisha			111,134 pieces	110,098 pieces	143,967 pieces	
Shark fins[c]	2	3	0		1	
Bêche de mera				40	58	
Lobstera					4.6	
Live fish[a]		20.4	58.8	0	0	0

A$ = Austrialian dollar, t = ton.

[a] Preston (2008).

[b] present study estimates.

[c] the shark fins would equate to 118–152 t of live sharks.

Source: National Statistics Office unpublished data, except where indicated.

often incomplete and inconsistent, Preston (2008) did not make an overall estimate, but presented the available data.

Fishery export data are shown in Table 5.2.

To estimate export production, fish sent as personal consignments must be added to the tabled quantities above. In 2006, consignments totaling 13.6 t (mainly reef fish, ocean fish, milkfish, and lobster) were exported (Fisheries Division 2008c).

A crude estimate placed export production from Kiribati coastal commercial fisheries in 2006 at 1,142 t plus 144,000 aquarium fish—all valued at A$1.9 million.

In a study commissioned by the Forum Fisheries Agency (FFA), there was a short survey of one of the most important fisheries of the country, trolling for tuna in South Tarawa (Sullivan and Ram-Bidesi, 2008[20]). The results of that survey show:

[20] The tuna trolling survey was carried out by Mike Savins, a fisheries specialist and long-time resident of Tarawa.

- In mid-2008, 126 active full-time commercial tuna trolling craft operated out of South Tarawa, plus 88 tuna trolling craft on a sporadic basis.
- An average of 6,300 kg of tuna and related pelagic species were sold per market day, or 126 t/month. To these commercial sales, some 5% should be added for domestic consumption to give a total landing of tuna of about 132 t/month, or 1,584 t/year.
- The market price of tuna was $2.65/kg. Tuna sales were about $334,000/month, or $4 million/year.

Nationwide in 2006, about 2,000 t of fish were purchased for A$5.9 million and 3,371 t of fish valued at A$8.4 million were caught for subsistence purposes, according to unpublished data from a 2006 household income and expenditure survey (HIES), kindly supplied by the Secretariat of the Pacific Community (SPC) Statistics and Demography Programme. Preston (2008) considers these estimates to be low. The prices used in the 2006 HIES were A$2.96/kg for purchased fish and A$2.50/kg for subsistence fish.

Discussions with the Director of Fisheries indicate that about 60%–70% of coastal fisheries production in Kiribati is for subsistence purposes. The commercial component has expanded in recent years due to increasing ice production in outer islands. Many islands now have cold storage (14 out of 33 islands), enabling storage for local sale and shipment to Tarawa (R. Awira, personal communication, October 2008).

Of importance in estimating fish consumption is the increased population of Kiribati by 15.4% between 2001 (the period covered by the Gillett and Lightfoot estimate) and 2007. South Tarawa's residents (40,311 in 2005 census) represent 44% of the total Kiribati population. The long-term trend of rural to urban (South Tarawa) migration has eased. The 2005 census data show a net flow of persons from the Gilbert Islands to the Line Islands during the inter-census period 2000–2005 (Anon 2007b).

Giving high credibility to the "Preston plus exports" estimate of 21,141 t, and selectively using other information in this section, it is estimated that coastal commercial production in the mid-2000s was 7,400 t valued at A$22 million.

Coastal Subsistence Catches

Coastal subsistence fisheries production in 1991 was estimated at 9,084 t worth $13.4 million (Dalzell et al. 1996), and in late 1990s at 10,000 t worth

$12.2 million (Gillett and Lightfoot 2001). With the information given above, it is estimated that the production from coastal subsistence fisheries in Kiribati in the mid-2000s was 13,700 t worth A$34 million.

Locally Based Offshore Catches

In recent years, no offshore fishing vessels were based in Kiribati. Substantial tuna catches are made by local trolling vessels, included in the coastal commercial catch estimate above.

Te Mautari, a government-owned company that began pole-and-line fishing in 1979, operated offshore fishing vessels, but by 2001 when it merged with other Kiribati government fishing entities, no functional fishing vessels remained. In recent years, the Fisheries Division periodically used a 13-meter catamaran (*Tekokona II*) for trial fishing and training, but it never achieved a commercial production level (Barclay and Cartwright 2007).

There is one Kiribati-registered purse seiner but, according to Fisheries Division staff, the vessel has not come to Tarawa in several years and is managed by an office located overseas. (R. Awira, personal communication, October 2008). It can be stated that, in national account terms, the center of economic operations of the vessel is not in Kiribati.

Foreign-Based Offshore Catches

In 2007, 337 foreign fishing vessels were licensed to fish in the Kiribati EEZ. The fleet consisted of 160 longliners, 171 purse seiners, and 6 pole-and-line vessels (Tumoa 2008).

Catch estimates of the foreign-based fleet in recent years are given in Table 5.3, based on FFA (2008), which used data sourced from the Oceanic Fisheries Programme of the SPC. Two features of the FFA/SPC data should be noted: (i) The prices are all "delivered" prices, those received at entry to the country in which they are usually sold whether for processing or consumption, and (ii) bycatch, an important component of longline fisheries, was excluded; thus, correction factors were used as shown to construct Table 5.3.

The above catches, price information in FFA (2008), and knowledge of the fisheries were used to give the catch values for the three foreign-based fleets (Table 5.4). The values given are "in-zone" values: destination market values less the cost of getting the catch from the Kiribati zone to those markets.

Table 5.3: Catch of Foreign-Based Offshore Fleets (t)

Item	2003	2004	2005	2006	2007
Foreign longline catch[a]	13,367	37,369	14,016	15,041	6,149
Foreign purse seine catch[b]	84,827	105,023	216,567	174,406	156,938
Foreign pole-and-line catch	236	600	0	0	128
Total	**98,429**	**142,992**	**230,583**	**189,447**	**163,215**

t = ton.

[a] Increased by 30% for bycatch.

[b] Increased by 5% for bycatch.

Sources: Forum Fisheries Agency (2008) and consultant's estimates for bycatch.

Table 5.4: Catch Values of Foreign-Based Offshore Fleets ($)[a]

Item	2003	2004	2005	2006	2007
Foreign longliners	39,016,404	129,919,299	46,696,204	57,090,431	22,359,622
Foreign pole-and-line	52,702,832	77,498,588	164,567,058	138,670,788	174,498,702
Foreign purse seiners	263,689	752,910	0	0	193,051
Total ($)	91,982,925	208,170,797	211,263,262	195,761,219	197,051,374
Total (A$)	**139,814,046**	**283,112,284**	**276,754,873**	**258,404,809**	**234,491,135**

[a] Values are from Forum Fisheries Agency (FFA) (2008) less 15% for transport costs and, in the case of longliners, bycatch.

Sources: Table 5.3, FFA (2008), and consultant's estimates.

Freshwater Fisheries

There is no freshwater fishery in Kiribati.

Aquaculture

Three types of aquaculture—milkfish, pearls, and seaweeds—are currently undertaken in Kiribati. Milkfish farming began in 2004 on a research and experimental station at Ambo and in 2008 produced a few hundred kilograms per month (R. Awira, personal communication, October 2008). Old fish ponds and surrounding earthworks at Temaiku, originally intended to grow baitfish for the export tuna fishery, have been resurrected by the Fisheries Division and operate as Temaiku Ecofarm, an integrated farming enterprise supplying fish, chickens, eggs, and pork to the local market on a semicommercial basis, i.e., sales revenue covers direct operating costs (ADB 2008b). The 2006 sale price of milkfish was A$2.20/kg (Fisheries Division 2008c).

Kiribati began investigating the culture of black pearls in 1996. After an encouraging start, the project had several difficult years and its future appears uncertain (ADB 2008b). There were harvests in 2003 and 2008, the 2008 harvest yielding a few hundred low-quality pearls (R. Awira, personal communication, October 2008). Price information from the Fiji Islands, Cook Islands, and Marshall Islands suggests an average farm-gate value of A$25 per pearl.

Seaweed farming has been undertaken with government subsidizing prices to encourage people to make a living in outer islands. A price of A$0.55/kg has been paid to seaweed farmers since the government raised the price in 2001 (R. Tumoa, personal communication, October 2008). This has propped up production and Kiribati still exports small quantities of dried seaweed, making a useful addition to household incomes (ADB 2008b). Nearly all production is from Fanning Island in the Line Group (very little is grown in the Gilbert Group because of disease) (R. Awira, personal communication, October 2008).

Recent quantitative data on aquaculture production, as reported to Food and Agriculture Organization of the United Nations (FAO), were kindly made available by the Fisheries Division staff (Table 5.5).

Considering the above information, annual Kiribati aquaculture production in 2007 is estimated at 143 t plus 100 pieces, with a farm-gate value of about A$90,000.

Table 5.5: Aquaculture Production as reported to FAO (t)

Item	2005	2006	2007
Milkfish	12	10	4
Seaweed	no data	1,104	139

FAO = Food and Agriculture Organization of the United Nations, t = ton.

Source: Fisheries Division (unpublished data).

Summary of Harvests

Based on data presented above, a crude approximation of the annual quantities and values[21] of the fishery and aquaculture harvests in 2007 is given in Table 5.6. The weak factual basis for the estimates of coastal commercial and coastal subsistence catches should be recognized.

21 The values in the table are dockside and/or farm-gate prices, except in the case of offshore foreign-based fishing where the value in local waters (overseas market prices less imputed transshipment costs) is given.

Table 5.6: Annual Fisheries and Aquaculture Harvest in Kiribati, 2007

Harvest Sector	Quantity (t)	Value (A$)
Coastal commercial	7,000	22,000,000
Coastal subsistence	13,700	34,000,000
Offshore locally based	0	0
Offshore foreign-based	163,215	234,491,135
Freshwater	0	0
Aquaculture	100 pieces plus 143	90,000
Total	**100 pieces plus 184,058 tons**	**290,581,135**

A$ = Australian dollar, t = ton.

Source: Consultant's estimates.

Contribution of Fishing to GDP

Current Official Contribution

Unpublished data from the National Statistics Office gives the nominal gross domestic product (GDP) for Kiribati by industry at current market prices. The "fishing" and "seaweed" contributions to GDP in recent years are given in Table 5.7.

Table 5.7: Kiribati GDP by Industry (A$'000)

Item	2003	2004	2005	2006	2007
Fishing	2,611	2,291	2,380	2,440	2,710
Seaweed	61	199	284	259	208
Kiribati GDP	87,507	87,920	85,144	84,287	84,195
Fishing and seaweed share of GDP (%)	3.1	2.8	3.1	3.2	3.5

A$ = Australian dollar, GDP = gross domestic product.

Source: National Statistics Office unpublished data.

Method Used to Calculate the Official Fishing Contribution to GDP

The staff of the National Statistics Office (R. Takarie, personal communication, October 2008) kindly provided summary details on the method used to calculate the fishing and seaweed contributions to GDP, but stressed that many of the details were known only to a senior statistician who recently retired. In summary,

- Commercial fishing is partitioned into several components: Central Pacific Producers (CPP), commercial fishing (Christmas Island), commercial (South Tarawa), and commercial (outer islands). CCP company accounts are used to determine the value added from that firm; for the other commercial fishing, information comes from "studies 1995–96," with the assumption that production increases each year by 5%–10%. The value added for each component is given in Table 5.8.
- Subsistence fishing is not included in the calculations. Subsistence in general was dropped from GDP calculations in 2006 ("Better to remove than just guess"). It is acknowledged that the HIES could be used to estimate subsistence contribution to GDP, but this has not been done yet.
- For seaweed, two components are considered: Atoll Seaweed Company and other producers. Company accounts are examined to get total value and value added.
- The value added for "pet (aquarium) fish" is not included because data are not available.

The most significant comment that can be made on this methodology obviously concerns the omission of subsistence fishing. This is acknowledged by the National Statistics Office. HIES information will be used to rectify the situation in the future. Excluding "pet fish" for lack of data may be addressed by using information available at the Fisheries Division.

Table 5.8: Value Added from the Components of Commercial Fishing (A$'000)

Fishing Component	2003	2004	2005	2006	2007
Central Pacific Producers	376	36	100	150	300
Commercial fishing (Christmas Island)	380	390	400	400	410
Commercial (South Tarawa)	1,575	1,580	1,590	1,600	1,700
Commercial (outer islands)	280	285	290	290	300
Commercial subtotal	2,611	2,290	2,380	2,440	2,710

A$ = Australian dollar.

Source: National Statistics Office unpublished data.

Alternative Estimate of Fishing Contribution to GDP

Table 5.9 presents an alternative to the official method of estimating fishing contribution to GDP in Kiribati. It is a simple production approach that takes the values of five types of fishing/aquaculture activities for which production values have been determined and summarized in Table 5.6. This alternative approach also determines the value added by using VARs characteristic of the type of fishing concerned. The VARs were determined by knowledge of the fisheries sector and use of specialized studies (Appendix 3).

The approach in Table 5.9 does not intend to replace the official methodology, but rather the results obtained can serve as a comparator to gain additional information on the appropriateness and accuracy of the official methodology—and possibly a need for modification.

The 2007 fishing contribution to GDP of about A$45 million is considerably more than the official fishing and seaweed contribution to GDP of about A$2.7 million given in Table 5.8. The official contribution is much lower because of the omission of subsistence fishing and the low contribution from commercial fishing, the latter being less than 20% of that from the alternative calculation.

A fishing contribution of A$45 million obtained through the alternative method is more than half of the official 2007 GDP of Kiribati. A valid comparison cannot be made, however, because the official GDP figure does not include subsistence activities of any kind.

Table 5.9: Fishing Contribution to GDP Using an Alternative Approach, 2007

Harvest Sector	Gross Value of Production (from Table 5.6)	Value-Added Ratio	Value Added (A$'000)
Coastal commercial	22,000	0.65	14,300.0
Coastal subsistence	34,000	0.90	30,600.0
Offshore locally based	0	0	0
Freshwater	0	0	0
Aquaculture	90	0.72	64.8
Total			**44,964.8**

A$ = Australian dollar, GDP = gross domestic product.

Source: Author's estimates.

Export of Fishery Products

The National Statistics Office website does not show export data after 2004. Unpublished data from that office show exports from Kiribati by commodity through 2007. Unfortunately, the data on many important fishery exports are incomplete after 2004.

To make an estimate of 2006 fishery exports of Kiribati, data and estimates for exports of coastal fisheries—1,142 t (plus 144,000 pet fish) worth A$1.9 million (section 5.1)—were added to the seaweed exports—155 t worth A$622,000 (National Statistics Office unpublished data)—and taken to be all the fishery exports of the country. Thus, a crude estimate of fishery exports in 2006 is about 1,300 t worth about A$2.5 million.

In the unpublished data, the total domestic exports[22] of Kiribati in 2006 were given as A$2,894,000. This value does not, however, include copra exports, which are relatively important. Extrapolating recent copra exports to 2006 gives adjusted total domestic exports of about A$4.3 million in 2006.

Given the limitations of the data, fishery exports are the most important export of Kiribati. They were about 75% greater in value than copra in 2006, when fishery exports were about 58% of all exports.

Government Revenue from Fisheries

Access Fees for Foreign Fishing

The access fees paid by foreign fishing vessels for fishing in Kiribati waters are extremely important to the country, as shown in Table 5.10.

The government's total recurrent revenue is given in the approved budget for 2008 (Government of Kiribati 2008). The actual for 2006 was A$60,026,000 and the "revised budget" for 2007 was A$60,928,000. The major revenue items for the government included fishing licenses (about A$25 million), import duties (A$18 million), and income tax (A$11 million).

Thus, the access fees received from foreign fishing made up 43% of total recurrent revenue for 2006 and 42% in 2007. These fees amount to A$156/t of fish caught (given the amount of fish caught in the Kiribati exclusive economic zone (EEZ) by foreign fishing [163,215 t in 2007, section 5.1]).

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22 Does not include reexports.

Table 5.10: Kiribati Fishing License Revenue, from Various Sources (A$)

Year	Ministry of Finance	Fisheries Division 2006 Annual Report	Fisheries Division 2003 Annual Report
2001	46,404,039		
2002	41,719,107		
2003	31,281,142		31,461,300
2004	Not available	26,645,812	
2005	24,586,751	25,673,127	
2006	25,825,463	26,350,934	
2007	25,419,845		

A$ = Australian dollar.

Sources: Ministry of Finance and Economic Development unpublished data; T. Kaureata (personal communication, October 2008); Fisheries Division (2004); Fisheries Division (2008c).

Other Government Revenue from Fisheries

The other significant sources of direct government revenue from fisheries activities totaled A$62,479 in 2006 and A$97,085 in 2007, made up as follows (Government of Kiribati 2008):

- Sales of fish and fish posters: A$15,960 in 2006
  A$12,575 in 2007
- Pleasure fishing licenses: A$23,329 in 2006
  A$27,966 in 2007
- Fees for transshipment of fish:[23] A$4,017 in 2006
  A$4,568 in 2007

The Fisheries Division annual report for 2006 (Fisheries Division 2008c) gave some additional (and sometimes conflicting) information on this revenue.

- In 2006, the transshipment activity in Betio Port commenced in July and ended in December. A total of 93,026 t of tuna was transshipped in the port, giving a total revenue of $205,129 to be collected. However, only $164,512 was collected, leaving a receivable balance of $40,616.35.

23 These fees appear too low to be the entire transhipment fees.

- Tourists engaged in recreational fishing of bonefish and in diving are required to pay a license fee of A$35, which is valid for the duration of their stay. The permits yielded A$13,860 in 2006, lower than in peak years when more than A$20,000 was received.
- In 1999, an annual "observer fee" was initiated at A$400 per vessel, increasing to A$600 per vessel in 2006, when A$7,768 was received.
- The Fisheries Division licenses both local and foreign entrepreneurs for exporting coastal marine products. Four license categories are listed under the "Processing and Establishment Licence," which yielded the following: (i) foreign investor (100% foreign-owned) A$5,000; (ii) semi-foreign (foreigner owns more than 50%) $3,500; (iii) semi-foreign (local owns more than 50%) $1,500; and (iv) local company (base fee) $300. Thus, total fees collected in 2006 were $11,525.

Employment

The 2005 Kiribati census provided some information on employment related to fisheries. In the census, "working" is defined as any activity concerned with providing the necessities of life. Respondents were coded in the questionnaire into three mutually exclusive categories of "cash work," "village work," or "no work." A person who is employed or works mainly for cash is a cash worker. Persons doing village work are those performing a variety of tasks involved in growing or gathering produce or in fishing to feed their families; they are described as subsistence farmers or fishers. Results of the census showed:

- Village work (subsistence farmers or fishers), such as growing or gathering of produce or fishing to feed their families, was the main activity of 39% of males and 36% of females 15 years and older. The proportion of village workers was much higher in the rural (outer islands) areas (51%), than in South Tarawa (urban), where only 20% were village workers.
- The great majority of employed cash workers in Kiribati are employed in the public administration sector—6,953 persons or 53% of the total employed. The other three industry groups that have a significant proportion of employed persons are transport and communication, 1,473 (11%); retail trade, 1,179 (9%), and agriculture and fishing, 936 (7%).

- Apart from government jobs, the other sources of employment for males are the fishing vessels and especially the merchant and/or container boats and tankers.

The results of the 2000 census had more detail on fisheries employment (Table 5.11). "Fisheries" was the main activity for 1.5% of the population.

Table 5.11: Type of Activity Done in Previous Week, by Gender

Occupation	Total	Male	Female
Fisheries	204	187	17
Legislators and officials	667	485	182
Professionals	2,506	1,119	1,387
Technicians	1,201	679	522
Clerks	1,829	717	1,112
Service workers	2,276	1,236	1,040
Agriculture	635	445	190
Trade workers	1,039	737	302
Plant and/or machine operators	1,462	1,402	60
Elementary occupations	794	738	56
Not stated	520	350	170
Total	**13,133**	**8,095**	**5,038**

Source: 2000 census.

The report of the 2006 Kiribati HIES (Tiroa 2007) does not disaggregate sources of income to a level where the fishing contribution can be seen. It gives the source of income at the level of wages and salary, self employment, agricultural and fish sales, and others. Wages and salaries accounted for 35% of the total income of Kiribati and subsistence activity accounted for 22%. Other major sources of income included imputed rents (14%), agricultural and fish sales (11%), remittances and gifts (10%), and sales of home produce (5%).

Fisheries Division (2008c) compiled the results of several years of surveying households for participation in fishing activities (Table 5.12). The table shows that, even in highly urbanized South Tarawa, subsistence fishing is quite important. The large differences between the South Tarawa results of 2005 and 2006 raise some concern about survey methodology.

Table 5.12: Results of Fishing Household Surveys

Item	Tamana	Tamana	Arorae	Arorae	North Tarawa	North Tarawa	South Tarawa	South Tarawa
Year surveyed	2002	2006	2001	2006	2003	2006	2005	2006
Households (number)	214	196	244	275	693	693	4,529	5,245
Fishing households (%)	95.1	93.0	91.1	88.0	94.0	96.0	75.0	57.0
Nonfishing households (%)	4.9	7.0	8.9	12.0	6.0	4.0	25.0	43.0
Full-time fishing households (%)	3.4	6.0	16.7	4.0	3.0	5.0	7.0	8.0
Part-time fishing households (%)	31.1	13.0	19.4	5.0	22.0	17.0	6.0	14.0
Subsistence fishing households (%)	65.5	81.0	63.9	91.0	74.0	78.0	87.0	78.0

Source: Fisheries Division (2008c).

The FFA-commissioned survey of tuna trolling in South Tarawa in 2008, described in section 5.1, showed, with regard to employment:

- There were on average 3 fishermen and 1.5 women fish handlers/sellers for each of 126 full-time commercial tuna troll fishing craft.
- About 189 women were involved full-time in the sale of tuna (full-time equivalent; two half-time is equivalent to one full-time). Some men were involved in tuna sales, primarily buying fish from several fishing operations.
- Commercial fishing was carried out by men only and 99.5% of fish sellers were women, normally the wives of the fishermen.
- The 2008 market price of tuna, A$2.65 kg, and tuna sales of A$4 million/year represented about A$21,000 in sales annually per full-time seller.

Additional information on fisheries employment in the country are provided below.

- In the mid-1990s, 226 Kiribati men were working in 10 major foreign fleets in the Pacific islands area (Gillett and McCoy 1997).

In 2005, 325 Kiribati crew were contracted to the Japanese fleet, and 100–200 more contracted to the Republic of Korea and Taipei,China fleets (Barclay and Cartwright 2006).

- Central Pacific Producers (CPP), a fishing and processing company fully owned by the government, employed 70 people in April 2008, including 20 women—most of whom were clerical staff. Two or three women were employed in loining and/or processing and the processing supervisor was a woman (Gillett et al. 2008).
- A significant sport fishery is located on Kiritimati, where overseas anglers visit to fish for bonefish and, to a lesser extent, for large coastal pelagic species, such as trevallies, wahoo, tunas, and, occasionally, marlins. Kiritimati also attracts a small number of divers. Sport fishing generates economic benefits of some A$2.5 million/year for Kiritimati through sport-fishing license fees, jobs for about 70 professional fishing guides, and tourist expenditure in the island's hotels (Preston 2008).
- Employment in commercial tuna fishing in recent years is shown in Table 5.13.

Table 5.13: Local Employment in the Tuna Industry

Item	2002	2006	2008
Local jobs on vessels	39	15	15
Local jobs in shore facilities	47	80	70
Total	**86**	**95**	**85**

Source: Gillett (2008).

The above information implies that the reports of the recent census and HIES are not sufficiently disaggregated to show much about formal employment in fisheries or the importance of self-employment in the fisheries sector. Results of fishery-focused surveys give greater detail but they are mostly narrow in scope (i.e., one company, one island, one subsector) and there are suggestions of problems with sampling strategy. These two factors result in more difficulty in quantifying the importance of fisheries employment to the Kiribati economy (i.e., the ratio of fisheries jobs to total jobs) than for other features, such as exports (fishery exports versus total exports).

Fish Consumption

Daily per capita fish consumption for the 18 islands in the Gilbert and Line groups in the 1980s was estimated to range from 0.45 kg in South Tarawa to 2.86 kg in Arorae; of the 18 islands listed, 11 (61%) of the islands had a per capita consumption of fish greater than 1.0 kg/day, based on information from the 1985 census (Nube 1989). According to IMM (1993), the estimated catch in the Gilbert group translates into a fish annual supply of 207.0 kg per capita.

For the country as a whole, the World Bank (1995), quoting FAO sources, stated that "Per capita supplies [of fish] available for consumption are…quite high ranging between 72 and 75 kg/year over the last decade." The World Bank (2000) also stated that in Kiribati, 67% of total animal protein was from seafood. Annual per capita supply of seafood in 1995 was 150 kg, based on FAO production, import, and export data (Preston 2000).

Fish consumption surveys in 2003 (Fisheries Division 2004) estimated a daily per capita value of 253.4 grams, or 92.5 kg/year. A fish consumption survey in 2005 (Fisheries Division 2006) showed annual per capita values of 32.6 kg in Makin, 68.8 kg in Maiana, and 36.9 kg in Nonouti. The Statistics Unit of the Fisheries Division later stated that "an average I-Kiribati consumes 241 g of fish per day (2000 to 2003 estimates)." This equated to 87.9 kg per year.

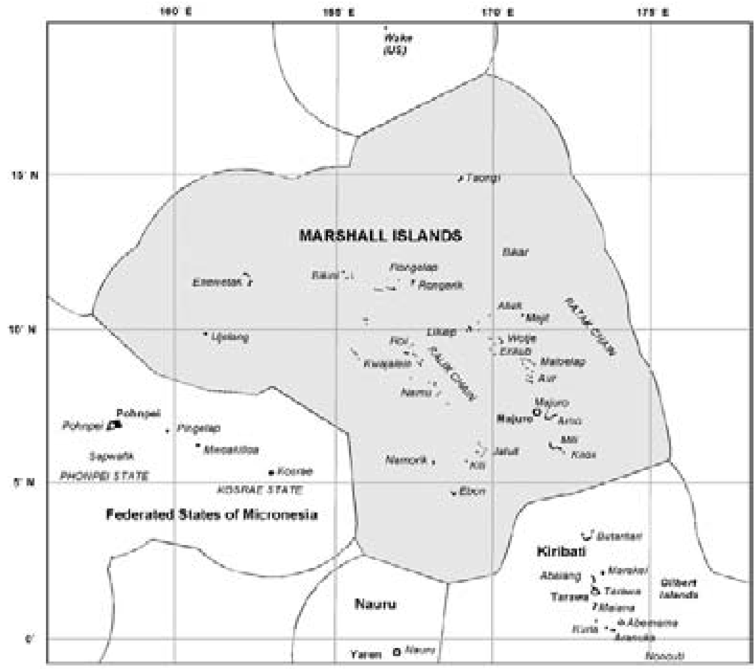
Some recent studies focused on tuna consumption. Tuna landings in South Tarawa (where data are most reliable) in late 1990s were 26–33 t/week, according to data in Gillett and Lightfoot (2001). Based on an average of 30 t/week, this was equivalent to an annual per capita tuna supply of about 50 kg for the population of 30,000. Data in Sullivan and Ram-Bidesi (2008) indicate an annual tuna catch in South Tarawa of 1,584 t/year. Considering the population had then reached 40,300 in South Tarawa (Anon 2007b), the apparent annual per capita consumption was about 39 kg of tuna.

Data from an HIES in 2006 (Bell et al. 2009) suggested annual per capita fish consumption in Kiribati of 62.2 kg (whole weight equivalent), of which 92% was fresh fish. For rural areas, it was 58.0 kg, and for urban areas, 67.3 kg. There is, however, at least some contention that the HIES data underestimate fish production and consumption (section 27.1).

Sullivan and Ram-Bidesi (2008) considered much of the recent literature on fish consumption in Kiribati and stated: "What is clear is that (a) fish and fish products remain a very significant part of total animal protein supply in Kiribati and (b) tuna species remain the single most common and important marine resource consumed in Kiribati."

Some of the older fish consumption studies indicate that Kiribati has the highest rate of fish consumption in the world. The various studies also show large variation in annual per capita rates between studies and between islands within studies.

Marshall Islands



Source: Secretariat of the Pacific Community.

Fish Production

Coastal Commercial Catches

Coastal commercial fisheries production in early 1990s was estimated at 369 t worth $714,504 by Dalzell et al. (1996), based on information from the FFA fisheries profiles (Smith 1992b) and from a nutritional survey in 1990 (Anon 1991). For the late 1990s, production was estimated at 444 t valued at $973,000 by Gillett and Lightfoot (2001), based on the Dalzell et al. (1996) estimate and seven other sources of information.

Additional information that could be used to update these production estimates comes from data on the purchases of fish in the outer islands by the Marshall Islands Marine Resources Authority (MIMRA), 2002 HIES, Overseas Fishery Cooperation Foundation (OFCF) fishery surveys, and data on the exports of products from coastal commercial fisheries.

Fish purchases by MIMRA in the outer islands give some insight on commercial fisheries production in non-Majuro atolls of the country. MIMRA purchases at those locations are thought to represent somewhat more than half of all commercial fisheries production (G. Joseph and D. Jack, personal communication, October 2008). The three latest MIMRA annual reports (MIMRA 2006, 2007, 2008a) give the amounts of fish purchased by the authority during the 3 fiscal years:

FY2005:

- Arno: 15,743 kg for $31,983
- Jaluit: 8,188 kg for $13,135
- Maloelap and Aur: 5,278 kg for $7,472
- Ailinglaplap, Namu, Likiep, and Ailuk: fish purchased over 3 years: $46,479.69, or $15,493/year (for an estimated 9,781 kg/year)

FY2006:

- Arno: 14,643 kg for $27,916
- Jaluit: 8,621 kg for $16,052
- Maloelap and Aur: 8,202 kg for $19,657
- Fish bases on atolls supplying Kwajalein Fish Market: zero (no transport)

FY2007:

- Arno: 10,567 kg for $20,331
- Jaluit: 7,912 kg for $13,692
- Maloelap and Aur: 9,169 kg for $16,623
- Fish bases on atolls supplying Kwajalein Fish Market: zero (no transport)

The above data indicate that during the 3 years, MIMRA purchased annually an average of 32.6 t of fish for $60,784. If the MIMRA purchases represented 50% of the commercial fishing production in areas away from Majuro/Arno, then there was about 70 t of commercial production in the outer islands.

The 2002 HIES (EPPSO 2002) indicated that fisheries production was 583 t worth $2,623,930. Staff of EPPSO cautioned that, due to very limited coverage of non-urban areas, the results are likely to be applicable only to Majuro and Ebeye (C. Hacker, personal communication, October 2008).

An OFCF and MIMRA survey in 2004 estimated that the total annual coastal fishery catch in Majuro was 947 t, of which 535 t were sold (OFCF and MIMRA 2004). At a price of $1.40 to the fishers, the total value to them was $1,652,798.

In 2004, the annual total catch was 353 t, made up of 249 t reef fish, 61 t pelagic fish, and 43 t of shellfish and other items. In 2005, the annual total catch was 463 t, made up of 350 t reef fish, 38 t pelagic fish, and 75 t shellfish and other items. Total sales were 292 t and self-consumption 171 t (OFCF 2006).

Exports of products from coastal fisheries in the Marshall Islands are significant: aquarium fish (40,000 pieces in 2006), coral, and trochus were exported (MIMRA 2008a).[24] Staff of EPPSO indicated that no effective monitoring of exports, including fishery exports (C. Hacker, personal communication, October 2008). Coastal fishery product export statistics reported to FAO (for which there is some degree of verification using importing country data) are shown in Table 6.1.

Table 6.1: Major Coastal Fishery Exports of the Marshall Islands, 2006

Product	Value[a] ($'000)
Ornamental fish	391
Coral and the like	181
Miscellaneous corals and shells	35
Mollusks and other aquatic invertebrates, live, fresh, or chilled, nei	16
Ornamental saltwater fish	16
Other aquatic invertebrates, frozen	9
Miscellaneous mollusks, other than live, fresh, or chilled, nei	8
Ornamental freshwater fish	5
Clams, shucked or not, live, fresh, or chilled	4
Other aquatic invertebrates, live, fresh, or chilled	2
Crabs, peeled or not, fresh, or chilled	1

nei = not elsewhere included, FOB prices.

[a] Values are free on board (FOB).

Source: Statistics reported to the Food and Agriculture Organization of the United Nations.

[24] All giant clam exports from the Marshall Islands are from culture operations.

Fish values in the mid-2000s can be approximated by (i) assuming a MIMRA outer island buying price of $2.20/kg, (ii) assuming a Majuro buying price of $3.09/kg, and (iii) reducing FOB values on Table 6.1 to approximate prices to fishers.

Selectively using the above information, annual coastal commercial fisheries production in the Marshall Islands in the mid-2000s is estimated to be 950 t worth $2.9 million.

Coastal Subsistence Catches

A subsistence production of 2,000 t worth $3,103,213 in the early 1990s was estimated by Dalzell et al. (1996), and at 2,800 t worth $3,836,000 in the late 1990s by Gillett and Lightfoot (2001). After the latter estimate, the population of the Marshall Islands increased by 3.6% by the end of 2007, which would tend to increase demand for fish. However, there was an increasing concentration of people in Majuro, which would tend to reduce the importance of subsistence fish production.

Additional information that could be used for making a new estimate includes the 2004 OFCF/MIMRA Majuro survey, which estimated subsistence production in Majuro at 412 t, representing 43% of all coastal fisheries production in Majuro; and the 2005 OFCF Arno survey, which estimated subsistence production in Arno at 172 t, representing 37% of all coastal fisheries production in Arno.

Stanley (2005) cited two estimates of subsistence fisheries production in the country: "According to the Meto 2000 Report, approximately 1,500 to 1,700 t of fish per annum are harvested and consumed by households. This contrasts with estimates in the Vision 2018 Marshall Islands Fisheries Sector Master Plan, which puts yearly subsistence fisheries landings in a range of 3,125 to 5,470 t."

The price of subsistence fish can be approximated by taking the MIMRA outer island buying price ($2.20/kg) and using the farm-gate system of valuing subsistence production in the Pacific islands, i.e., discounting the MIMRA price by 30% as an allowance for getting the product to market.

Using the above information, coastal subsistence fisheries production in the Marshall Islands in the mid-2000s is estimated to be 2,800 t worth $4,312,000.

Locally Based Offshore Catches

Estimates of catches of the four main commercial species of tuna in the WCPFC area for 1997–2007 were made by the Forum Fisheries Agency (FFA 2008), using data from the Oceanic Fisheries Programme of the SPC. In these data, prices are all "delivered" prices in that they reflect the price received at entry to the country in which they are usually sold, whether for processing or consumption. Also, bycatch was not included, although it is an important component.

Catches by foreign longliners based in Majuro, as inferred from FFA (2008), are quite different from those estimated by monitoring catch offloading by MIMRA. Discussions with the Fisheries Database Supervisor at SPC suggest that this is an artifact of the relatively high coverage of operational data for the PRC fleet in the Marshall Islands compared to other areas in the western Pacific, and consequently the MIMRA estimates are likely to be closer to the actual catch (P. Williams, personal communication, November 2008).

Catches of locally based longliners and of the Marshallese-flagged purse seiners are given in Table 6.2.

Table 6.2: Catch of Locally Based Offshore Fleets (t)

Item	2004	2005	2006	2007
Locally based longliners (from MIMRA, increased by 30% for bycatch)	2,059	2,743	3,484	3,363
Locally based seiners (from FFA, increased by 5% for bycatch)	48,912	58,972	43,113	60,206
Total	**50,971**	**61,715**	**46,597**	**63,569**

FFA = Forum Fisheries Agencies, MIMRA = Marshall Islands Marine Resource Authority, t = ton.

Sources: Forum Fisheries Agency (2008), Marshall Islands Marine Resource Authority (MIMRA) annual reports, MIMRA (2008b).

Table 6.3: Catch Value of Locally Based Offshore Fleets ($)

Item	2004	2005	2006	2007
Locally based longliners[a]	8,314,242	11,704,381	13,810,576	15,846,456
Locally based seiners[b]	35,799,984	44,309,541	33,310,298	65,363,934
Total	**44,114,226**	**56,013,922**	**47,120,874**	**81,210,390**

[a] From Forum Fisheries Agency (FFA) (2008), with destination market values (i) reduced by 25% to obtain dockside tuna values; and (ii) increased by 10% to account for the sale of bycatch.

[b] From FFA (2008), with destination market values decreased by 15% for transshipment costs.

Sources: Table 6.2 and FFA (2008).

The above catches, price information in FFA (2008), and knowledge of the fisheries were used to give dockside catch values for the two locally based fleets (Table 6.3).

Foreign-Based Offshore Catches

Catches by foreign vessels in 2007 are shown in Table 6.4.

Table 6.4: Catch of Foreign-Based Offshore Fleets, 2007

Fleet	Catch (ton)
Foreign longliners[a]	378
Foreign pole-and-line vessels	4,548
Foreign purse seiners[b]	7,801
Total	**12,727**

Note: A large difference exists between the foreign purse seine catch given in FFA (2008) and that given by MIMRA (2008b), which could not be reconciled by early January 2009. For consistency with other sections of this report, the data in FFA (2008) were used here.

[a] Forum Fisheries Agency (FFA) (2008) catch increased by 30% for bycatch.

[b] FFA (2008) catch increased by 5% for bycatch.

Sources: FFA (2008) and Secretariat of the Pacific Community (unpublished data, 2008b).

The above catches, price information in FFA (2008), and knowledge of the fisheries were used to give the catch values for the three foreign-based fleets (Table 6.5). The values given are "in-zone" values: destination market values less the cost of getting the catch from the Marshall Islands' zone to those markets.

Table 6.5: Catch Value of Foreign-Based Offshore Fleets, 2007 ($)

Fleet	Value[a]
Foreign longliners	1,510,760
Foreign pole-and-line vessels	6,815,465
Foreign purse seiners	11,246,487
Total	**19,572,712**

[a] Values are from Forum Fisheries Agency (FFA) (2008) decreased by 15% for transport.

Sources: Table 6.4 and FFA (2008).

Freshwater Catches

No freshwater fisheries are conducted in the Marshall Islands.

Aquaculture Harvests

In recent years, two types of aquaculture—giant clams and black pearls—were conducted with significant production.

Discussions with MIMRA staff and commercial clam farmers indicate that in 2007, one commercial clam farm and two farms existed that operated primarily for stock enhancement purposes, but which also made some commercial sales. Giant clam production in the Marshall Islands in recent years reached 20,000–30,000 pieces of 2.5 cm each, with a farm-gate value of about $3.50 per piece. A production of 25,000 clams equates to $87,500.

The most recent harvest of cultured black pearls was in early 2005 when 2,000–3,000 pearls were harvested, each with a farm-gate value of $50[25] (M. Nair, personal communication, October 2008).

For the purpose of the present study, annual aquaculture production in the Marshall Islands in recent years is estimated to be 25,000 pieces worth $130,000.

Table 6.6: Annual Fisheries and Aquaculture Harvest in the Marshall Islands, 2007

Harvest Sector	Quantity (t)	Value[a] ($)
Coastal commercial	950	2,900,000
Coastal subsistence	2,800	4,312,000
Offshore locally based	63,569	81,210,390
Offshore foreign-based	12,727	19,572,712
Freshwater	0	0
Aquaculture	25,000 pieces	130,000
Total	**25,000 pieces plus 80,046 t**	**108,125,102**

t = ton.

[a] The values in the table are dockside and/or farm-gate prices, except in the case of offshore foreign-based fishing where the value in local waters (overseas market prices less imputed transshipment costs) is given.

Sources: Tables 6.1–6.5 and consultant's estimates.

[25] Although this price is relatively high compared to pearls from other Pacific island countries, MIMRA officials confirm that it is indeed realistic, given the rarity value of pearls from the Marshall Islands (G. Joseph, personal communication, October 2008).

Summary of Harvests

From the above sections, a crude approximation of annual production and value in 2007 was made (Table 6.6). The extremely weak factual basis for the estimates of coastal commercial and coastal subsistence catches should be recognized.

Contribution of Fishing to GDP

Current Official Contribution

The contribution of fishing to the Marshall Islands gross domestic product (GDP), obtained from the national accounts, is shown in Table 6.7.

Table 6.7: Fishing Contribution to Marshall Islands' GDP ($'000)

Item	FY2003	FY2004	FY2005	FY2006	FY2007
"Fishing" component of GDP	572	590	620	657	679
Total GDP	124,145	132,475	139,343	145,345	156,125
Fishing share of GDP (%)	0.5	0.4	0.4	0.5	0.4

FY = fiscal year, GDP = gross domestic product.

Source: Economic Policy, Planning, and Statistics Office (2008a).

Method Used to Calculate the Official Fishing Contribution to GDP

Staff of the Economic Policy, Planning and Statistics Office (EPPSO) provided information on the methodology for calculating the official fishing contribution to GDP (C. Hacker, personal communication, October 2008). The income approach to calculating GDP is used because income data are readily available through social security records. The "fishing sector" consists of only those salaried employees who contribute to social security. There is another sector called "subsistence," which includes subsistence fishing, but the precise proportion of fishing in that category is unknown and the total amount for "subsistence" is only a crude estimate because the most recent HIES had poor rural coverage.

The text of the national accounts (EPPSO 2008a) contained footnotes concerning fishing:

- It lists an "Offshore fishing surplus" ($5.7 million in 2007), with a footnote stating that it is the "Estimated surplus of RMI-based longline fishing and shore-based fish processing under foreign investment (tax holiday) exemptions."
- Another footnote states "Does not include purse seine operations, which are treated as outside the economic territory of the RMI and so are not included in GDP."

Regarding the method used to calculate the official fishing contribution to GDP in the Marshall Islands, it appears that the "fishing" sector does not include all that is fishing (i.e., omits subsistence fishing and apparently most small-scale commercial fishing), but does include some items that are not fishing (e.g., fish processing).

Purse seine operations, regardless of place of incorporation, are managed out of Majuro and have a substantial physical base for provisioning and maintenance of vessels. According to international standards for balance of payments and national accounts statistics, the catch of these resident purse seine operators sold to nonresidents should be included in exports, and value added derived from total catch should be included in GDP (Z. Abbasi, Pacific Island Financial Technical Assistance Centre, personal communication, November 2008).

Alternative Estimate of Fishing Contribution to GDP

Table 6.8 presents an alternative to the official method of estimating fishing contribution to GDP in the Marshall Islands. It is a simple production approach that takes the values of five types of fishing and/or aquaculture activities for which production values were determined above (summarized in Table 6.6) and determines the value added by using VARs characteristic of the type of fishing concerned. The VARs were determined by knowledge of the fisheries sector and by use of specialized studies (Appendix 3).

The approach in Table 6.8 is not intended to replace the official methodology, but rather the results obtained can serve as a comparator to gain additional information on the appropriateness and accuracy of the official methodology—and possibly a need for modification.

Total value added from fishing in Table 6.8 ($41.8 million for calendar year 2007) is considerably greater than the official estimate of "fishing" of $679,000 for FY2007.

Table 6.8: Fishing Contribution to GDP Using an Alternative Approach, 2007

Harvest Sector	Gross Value of Production ($, from Table 6.6)	Value-Added Ratio	Value Added ($)
Coastal commercial	2,900,000	0.75	2,175,000
Coastal subsistence	4,312,000	0.85	3,665,200
Offshore locally based	81,210,390		
Longline	15,846,456	0.20	3,169,291
Purse seine	65,363,934	0.50	32,681,967
Freshwater	0	0	0
Aquaculture	130,000	0.55	71,500
Total			**41,762,958**

Source: Section 6.1.

Regarding the status of foreign longliners in the Marshall Islands' economy for GDP purposes, the following points were made by McKinlay (2007):

- "A fishing vessel becomes resident only if the operator establishes a base in the country … otherwise the residence of the vessel remains that of the operator, regardless of the area in which it is fishing."
- "Usual practice: Treat vessel as resident if it has a base in the country for longer than one year."

If these two criteria are applied to the locally based foreign fleets that operate out of Majuro, those fleets should definitely be considered as part of the Marshall Island's economy for GDP purposes. However, for some reason, should those longliners not be considered as part of the Marshall Islands' economy, the equivalent gross value of production for just the locally based and locally registered Marshallese longliners was about $30,000 in 2007.[26] The value added from those local longliners would be about $6,000.

Export of Fishery Products

In the Marshall Islands, there is no effective monitoring of exports (C. Hacker, personal communication, October 2008). To obtain information on the

26 Four Marshallese longliners began fishing in January 2008, but their catch is not covered here.

export of fishery products from the country, unofficial sources of information must be used.

Tuna exports are the most important fishery export of the country (Table 6.9). A tuna processing plant operated in Majuro for several years. It was built in 1999, reached maximum production a few years later, and ceased operation in 2004. In 2003, the plant processed 11,400 t of tuna and produced exports worth $3,350,000 (EPPSO 2006). No exports from the plant were made in 2006 or 2007; it recommenced processing in April 2008 under new management.

Fishery product export statistics are reported to FAO and there is some degree of verification using importing country data. Although those statistics certainly have problems, they are at least indicative of the range of fishery

Table 6.9: Exports from Locally Based Longliners (t)

Year	Fresh Exports of Tuna and Bycatch	Frozen Exports and Local Sales
2004	1,628	455
2005	3,109	1,261
2006	2,764	1,478
2007	2,718	1,051

t= ton.

Source: Marshall Islands Marine Resource Authority annual reports.

Table 6.10: FAO Export Statistics for Fishery Products, Marshall Islands, 2006

Product	Value (FOB, $'000)
Skipjack tuna, frozen	7,899
Yellowfin tuna, frozen, nei	2,618
Bigeye tuna, fresh, or chilled	1,931
Fish fillets, fresh, or chilled, nei	1,815
Bigeye tuna, frozen, nei	892
Yellowfin tuna, fresh, or chilled	716
Fish fillets, frozen, nei	661
Sharks, frozen, nei	527
Ornamental fish, nei	391
Fish meat, whether or not minced, frozen, nei	208
Coral and the like	181

continued on next page

Table 6.10: continuation

Product	Value (FOB, $'000)
Miscellaneous corals and shells	35
Marine fish, fresh or chilled, nei	29
Marine fish, frozen, nei	28
Tunas nei, frozen	23
Mollusks and other aquatic invertebrates, live, fresh, or chilled, nei	16
Ornamental saltwater fish	16
Other aquatic invertebrates, frozen	9
Miscellaneous mollusks, other than live, fresh, or chilled, nei	8
Fish waste, nei	5
Ornamental freshwater fish	5
Clams, shucked or not, live, fresh or chilled	4
Other aquatic invertebrates, live, fresh, or chilled	2
Yellowfin tuna, heads-off, etc., frozen	2
Crabs, peeled or not, fresh, or chilled	1
Total	**18,022**

FOB = free on board, nei = not elsewhere included.

Source: Food and Agriculture Organization of the United Nations (2008).

exports (Table 6.10). The value of tuna exports is extremely low compared to the dockside value of the locally based longline fleet given in section 6.1.

From the information above, a crude estimate of the value of fishery exports in 2007 is: coastal exports, $450,000; aquaculture exports, $130,000; and exports from local longliners, $14.3 million (the dockside value of the catch in Table 6.6 was reduced to allow for local sales).

For purse seine fish, the large amount of tuna transshipped in Majuro lagoon should obviously not be considered as exports of the Marshall Islands. Dealing with the $65.4 million of catch by seiners based in Majuro (but who often fish and/or transship in the zones of other countries) is more complex.

The total of all exports is not known with certainty, but some estimates (e.g., $16.2 million of exports in 2006 [PITIC 2008]) do not include tuna.

Fishery exports of the Marshall Islands are given in Table 6.11, from the International Trade Centre export database derived from mirror data (partner countries trade data).

Table 6.11: Marshall Islands Fishery Exports ($'000)

Item	2002	2003	2004	2005	2006
All industries	227,132	197,797	155,153	778,629	873,660
Fish, crustaceans, mollusks, aquatic invertebrates	80,491	38,223	55,798	61,765	37,342
Share of fishery exports in products from all industries (%)	35.4	19.3	36.0	7.9	4.3

Source: International Trade Centre. www.intracen.org/appli1/TradeCom/TP_TP_CI.aspx?RP=584&YR=2002

Government Revenue from Fisheries

Access Fees for Foreign Fishing

Access fees in recent years are shown in Table 6.12.

Table 6.12: Access Fees Collected by MIMRA in Recent Years[a] ($)

Item	FY2005	FY2006	FY2007
Foreign-based fishing	2,088,921	1,314,712	1,058,139
Locally based foreign fishing	411,000	384,000	398,000
US treaty and FSM arrangement	152,063	1,093,285.64	497,505
Total	2,651,984	2,791,997.64	1,953,644
Total revenue and grants	85,600,000	94,800,000	98,900,000
Total domestic revenue	35,500,000	36,400,000	36,000,000
Access fees as proportion of domestic revenue (%)	7.5	7.7	5.4

FSM = Federates States of Micronesia, FY = fiscal year, MIMRA = Marshall Islands Marine Resources Authority, US = United States.

[a] The fees given in the table are for "fishing access" and do not include fees for carriers and tankers that service fishing vessels.

Sources: MIMRA annual reports, MIMRA unpublished data, EPPSO website: www.spc.int/prism/country/mh/stats/Economic.

In mid-2007, the population of the Marshall Islands was 52,701. The $1,953,644 received for foreign fishing access in 2007 was equivalent to $37 per person in the country.

Other Government Revenue from Fisheries

Other types of revenue received by the government from fishing activity in recent years are shown in Table 6.13.

Table 6.13: Other Fees (Non-Access) from Fishing Activity ($)

Fees	2004	2005	2006	2007
Transshipment fees	139,800	168,600	140,400	105,600
Other fees and charges	154,105	255,130	214,422	130,952
Total	**293,905**	**423,730**	**354,822**	**236,552**

Sources: Marshall Islands Marine Resources Authority (MIMRA) 2006 Annual Report, MIMRA unpublished data.

Employment

In early 2008, the Economic Policy, Planning and Statistics Office carried out an employment survey (EPPSO 2008b). The survey obtained data from Social Security records "plus EPPSO non-reported estimates." The results relevant to the fisheries sector are in Table 6.14.

Table 6.14: Marshall Islands Employment

	FY2000	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007
Number of Jobs								
Fishing	546	617	735	903	1,003	281	345	281
Total jobs in country	8,598	9,116	9,544	9,946	10,070	9,578	9,918	10,149
Total Earnings ($ million/year)								
Fishing	1,374	1,448	1,563	1,731	1,986	830	1,053	889
Total all jobs in country	16,132	17,496	17,873	16,762	16,748	16,155	17,672	18,937
Average Earnings ($/year)								
Fishing	3,088	3,091	2,768	2,464	2,558	5,508	5,415	6,207
Average all jobs in country	8,539	8,479	8,479	8,340	8,791	9,474	9,654	9,544

FY = fiscal year.

Source: Economic Policy, Planning and Statistics Office (EPPSO) (2008b).

Based on Table 6.14, many people are likely to be employed in fisheries jobs that do not make Social Security contributions. The accuracy of "EPPSO non-reported estimates" for these people not captured by the Social Security system is unknown, but seems low. The decline in "fishing" employment between 2004 and 2005 suggests that "fishing" includes nonfishing jobs, such as those at the tuna loining plant (that closed in late 2004). The plant "employed between 100 and 520 individuals annually between 1999 and mid-2004 as well as supporting surrounding services in addition to the import, processing and export of the tuna loins and fishmeal produced" (EPPSO 2008a).

If estimates in the table are accurate, fishing in 2007 provided 2.8% of the jobs in the country and 4.7% of the income from jobs. The income level of fishing jobholders was only about 65% of the average level.

Results of the 2002 HIES (which had some deficiencies related to nonurban coverage, section 6.1) contain information on fisheries employment—defined as participation in fishing during the week before the survey, are as follows:

- Out of 1,099 employed people in the country, "Agricultural and Fisheries workers" had only 25 jobs. The only fisheries category in "Agricultural and Fisheries workers" being "deep-sea fishery workers" in which only seven people were employed.
- 101 people (including 6 females) were involved in fishing "for home use."
- 54 people (including 2 females) were involved in subsistence fishing, and "sold any."

Another source of information on employment in fisheries is the OFCF and MIMRA survey in 1994, which indicated that 62.2% households on Majuro did at least some fishing once a year. This equated to 1,916 fishery households on Majuro. Still another source (Chapman 2004) indicated that in 2004, 10 full-time and 25–30 part-time vessels were trolling for tuna and other pelagic species around Majuro, while an unknown number were trolling around reefs and bird patches in the outer islands.

Employment in tuna fishing (fishing and postharvest) in recent years is shown in Table 6.15.

Table 6.15: Employment in Tuna Fisheries

Item	2002	2006	2008
Local jobs on vessels	5	0	25
Local jobs in shore facilities	457	100	116
Total	**462**	**100**	**141**

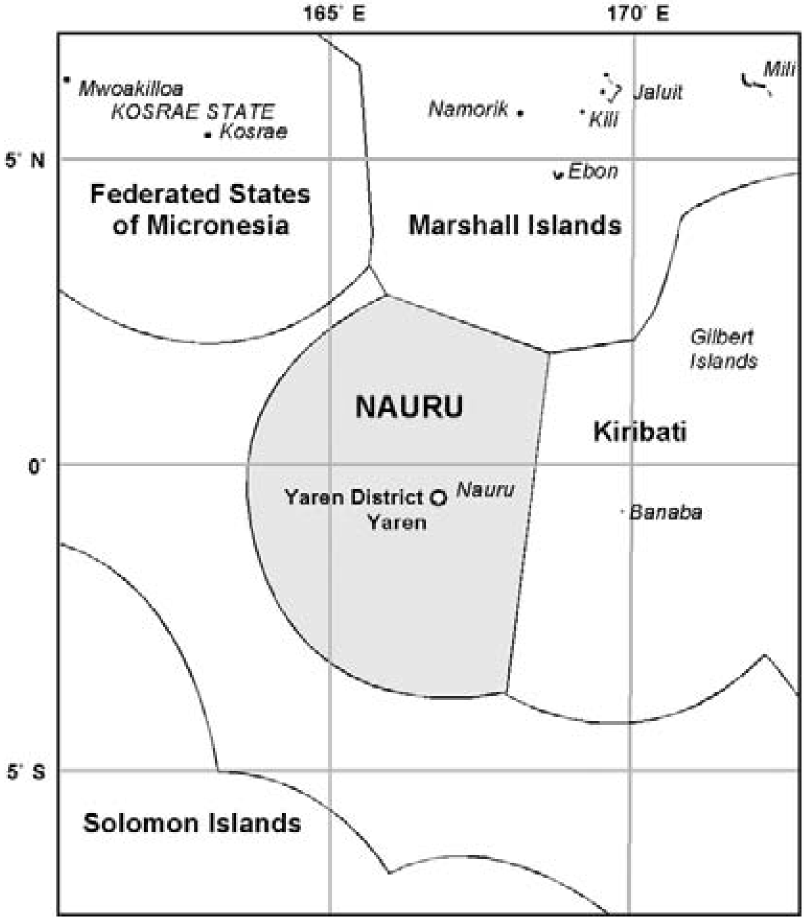
Source: Gillett (2008).

Fish Consumption

Discussions with a Majuro-based nutrition specialist indicate that there have been no general nutrition surveys in the last decade that involved fish consumption (I. DeBrum, personal communication, October 2008). However, some information on fish consumption is available from other sources, as follows.

- Annual consumption of fish per capita on Majuro in early 1980s was stated to be 31.7 kg, consisting of local fish 22.8 kg, canned fish 8.6 kg, and imported frozen fish 0.3 kg, according to a survey by the Japan International Cooperation Agency (JICA 1983).
- Johns Hopkins (1992) gave the frequency of eating eight categories of fishery foods in 75 households.
- Subsistence fishery contribution to fish consumption in the Marshall Islands was estimated to be 59.0 kg/year, according to Office of Planning and Statistics' worksheets for calculating the fishing component of GDP, which contain information from an early 1990s household expenditure survey.
- Burton et al. (1997) gave the average number of meals per week containing local fish and imported fish at Mili, Namu, and Laura.
- Apparent per capita supply of fish in the Marshall Islands in 1995 was 38.9 kg/year, based on FAO production, import, and export information (Preston 2000).
- Considerable difference was observed in consumption between the population centers of Majuro and Kwajalein, where 68% of the population resided in 1999, and the outer islands, where fish was relatively plentiful. Also, leakage of fish from the transshipment operations and longline bases in Majuro probably had a substantial effect on the supply of fish on that island (Gillett and Lightfoot 2001).
- Per capita consumption of "local marine animals" by the 1,915 people on Ailinlaplap Atoll in 2001 was shown to be equivalent to 42.3 kg annual per capita consumption (McCoy and Hart 2002).
- The OFCF and MIMRA (2004) survey estimated a fish supply equivalent to 39.9 kg/person/year for the 23,000 people on Majuro.

Nauru



Source: Secretariat of the Pacific Community.

Fish Production

Coastal Commercial Catches

The annual commercial fishery catch in early 1990s was estimated at 279 t worth $628,605, by Dalzell et al. (1996), citing Dalzell et al. (1992); and in late 1990s at 315 t worth A$514,250 (Gillett and Lightfoot 2001).

An SPC fisheries survey (Pacific Regional Coastal Fisheries Development Programme [COFISH] survey) around Nauru in October and November 2005 estimated the annual catch of finfish at 589.4 t,[27] with the majority caught for subsistence (55%–72%), some distributed on a non-monetary basis (17%–20%), and some sold (8%–27%). For invertebrates, the annual catch was estimated at 27 t, with all but some lobster catch used for home consumption (COFISH 2005).

A fisheries specialist who is both familiar with the COFISH survey of Nauru and now a resident of Nauru (T. Adams, personal communication, November 2008) observed that the COFISH survey period was somewhat atypical. There was a fuel shortage at the time of the survey, so there were no outboard skiffs operating. Those boats normally caught most of the tuna and coastal pelagic fish. The average landings per month of tuna alone were about 2.5 t (31 t/year), with others (mainly pelagic landings) adding another 2 t/month, according to 1999/2000 creel survey data (biased towards the boat-based fishery) published in the fisheries newsletter. This, however, would be an underestimate, because monitoring was probably not complete.

In April 2005, an SPC fisheries specialist visited Nauru (Chapman 2005) and confirmed that the fuel shortage affected fishing at that time, with fewer than 10 of the 30-40 outboard skiffs operating. He also noted that reef gleaning was also on the rise, especially in the previous 12 months. People were also eating sea urchins and bêche de mer, which was not done in the past.

Note that the Dalzell et al. (1996) and Gillett and Lightfoot (2001) estimates indicated that commercial fisheries production was about three times that of subsistence, while the COFISH (2005) estimate would mean that commercial fisheries production was only about one-fifth that of subsistence.

The difference may partly lie in profound changes in the Nauru economy that occurred between the periods covered by the Dalzell and CoFish surveys. There was increasing per capita consumption of seafood, directly related to the high reliance on seafood as a source of protein given the economic decline (COFISH 2005).

In 2007, the fuel situation was back to normal and a number of tuna boats departed from the ramps on most days (G. Preston, personal communication, November 2008). In February 2008, the fishing fleet in Nauru consisted of 40–50 motorized skiffs, with only about 20 used regularly. Around this time,

[27] Communication from SPC indicates that a revised estimate of total catch is 419.96 t (M. Kronen, personal communication, March 2009).

there were also about 70 actively used fishing canoes (Blanc and Templeton 2008).

The population of Nauru increased about 13% between the period covered by the Dalzell estimate and 2007 (Dalzell et al. 1992; SPC 2008a).

Catch rates were given by Rodwell (1998) using data collected by the Nauru Fisheries and Marine Resources Authority (NFMRA): small troll boats caught 70.0 kg/day and drop-stone boats caught 115.0 kg/day.

Prices during the 2006 HIES averaged A$2.12/kg for marketed local fish and A$1.53/kg for fish caught for subsistence. According to a fisheries specialist based on Nauru, fish prices at the landing place in late 2008 were in the range A$5–A$8/kg.

There is little factual basis for adjusting the 2005 COFISH estimate. Nevertheless, for the purpose of the present study, 2007 coastal commercial fisheries production on Nauru is estimated to be 200 t worth A$1 million.

Coastal Subsistence Catches

Annual subsistence fisheries in early 1990s were estimated at 98 t worth $219,600 (Dalzell et al. 1996), and in late 1990s at 110 t worth A$1,732,500 (Gillett and Lightfoot 2001). From information and approach used in the above section, it is estimated that production from coastal subsistence fisheries in Nauru in 2007 was 450 t worth A$787,000.

Locally Based Offshore Catches

No offshore fishing vessel currently operates from Nauru. The two longliners owned by the Nauru Fisheries Trading Corporation did not operate in 2007 and have never been fully operational (Anon 2008b).

Foreign-based Offshore Catches

In 2007, there were 131 foreign fishing vessels (all purse seiners) licensed to fish in the Nauru EEZ. The major participating entities were Japan (33 purse seiners), Taipei,China (33), and Republic of Korea (27) (Anon 2008b).

Estimates of catches of the four main commercial species of tuna in the Western and Central Pacific Fisheries Commission (WCPFC) area for 1997–2007 were made by the Forum Fisheries Agency (FFA 2008), using data from the Oceanic Fisheries Programme of the SPC. In these data, prices were all "delivered" prices in that they reflected the price received at entry

Table 7.1: Catches by Foreign-Based Offshore Vessels, Nauru Exclusive Economic Zone

Item	2003	2004	2005	2006	2007
Tuna catch (t)[a]	19,416	67,295	50,992	57,307	65,939
Destination value of tuna catch ($)[b]	15,139,002	60,756,520	47,830,333	56,388,594	88,890,402
Total catch (t)	20,387	70,660	53,542	60,172	69,236
"In-zone" value of total catch ($)	13,625,102	54,680,868	43,047,300	50,749,735	80,001,361
"In-zone" value of total catch (A$)	20,710,155	74,365,980	56,391,963	66,989,650	95,201,620

A$ = Australian dollar, t = ton.

[a] The tuna catch was increased by 5% for bycatch.

to the country in which they were usually sold, whether for processing or consumption. Bycatch was not included, although it was an important component.

Catches by the foreign-based fleet and their value in recent years are shown in Table 7.1, modified as noted in the table.

Freshwater Catches

There are four depressions on the Nauru plateau, the most significant one forming the 30,000 m² Buada Lagoon. The other water bodies, known as ponds, are on the fringing coast or just a few meters from the base of the escarpment. They range from about 40 m² to 10,000 m², either manufactured or naturally occurring. Anabar pond, at 10,000 m², is the most significant (NFMRA 2005). The ponds have become populated by tilapia, which is not popular as a food item (Tuara 1998).

In the present study, any harvesting from these brackishwater bodies is considered to be aquaculture.

Aquaculture Production

The Nauru Fisheries and Marine Resources Authority (NFMRA 2005) described the fall and rise of aquaculture in Nauru. Traditionally, juvenile milkfish were collected on the intertidal reef and reared in brackish ponds. The most important areas for farming were Buada Lagoon and, to a lesser extent, the Anabar pond. Farming was divided among families, with walls and fences, and the people had an intricate social fabric intertwined with milkfish culture. The Mozambique tilapia (*Oreochromis mossambicus*) was introduced around 1961 with assistance from the South Pacific Commission, but it was not accepted as a food source mainly because of its small size and poor flavor. Tilapia eventually infested all the milkfish ponds and competed for food. The result was that milkfish took longer to grow to an edible size and caused many farmers to abandon their traditional practice of raising milkfish. In 2000, the Buada Lagoon Owners Association introduced 10,000 milkfish fry from Kiribati into Buada Lagoon, reaping 5,000 adult fish some months later.

Currently, there are several milkfish grow-out ponds around Nauru; two extension officers provide advice to farmers. These are backyard and/or subsistence operations, but there is no good estimate of production. The last estimate was in 2006 when it was thought that annual milkfish production was about 8 t, providing livelihoods for 30 people (T. Adams, personal communication, November 2008).

Aquaculture production in Nauru in 2007 was estimated at 8 t worth A$18,000.

Summary of Harvests

From the above sections, a crude approximation of the annual quantities and values of the fishery and aquaculture harvests in 2007 was made (Table 7.2). The weak factual basis for the estimates of the coastal commercial and coastal subsistence catch should be recognized.

Table 7.2: Annual Fisheries and Aquaculture Harvest in Nauru, 2007

Harvest Sector	Quantity (t)	Value[a] (A$)
Coastal commercial	200	1,000,000
Coastal subsistence	450	787,000
Offshore locally based	0	0
Offshore foreign-based	69,236	95,201,620
Freshwater	0	0
Aquaculture	8	18,000
Total	**69,894**	**97,006,620**

A$ = Australian dollar, t = ton.

[a] The values in the table are dockside and/or farm-gate prices, except for offshore foreign-based fishing, where the value in local waters (overseas market prices less imputed transshipment costs) is given.

The above suggests that the bycatch from the offshore foreign-based fishing in the Nauru zone (deemed to be 5% of the purse seine tuna catch, Table 7.1) is about five times greater than all coastal commercial and subsistence fishing in Nauru.

Contribution of Fishing to GDP

Current Official Contribution

The fishing contribution to GDP in recent years is given in Table 7.3.

Table 7.3: Fishing Contribution to the Nauru GDP

	FY2004	FY2005	FY2006
Fishing contribution to GDP ($ million)	2.7	3.0	2.9
Nauru GDP (current prices) ($ million)	29.7	24.5	28.5
Fishing share of GDP (%)	9.1	12.2	10.2

FY = fiscal year, GDP = gross domestic product.

Source: Asian Development Bank (2007a).

Method Used to Calculate the Fishing Contribution to GDP

Compiling GDP estimates for Nauru was complicated by a number of special factors, according to ADB (2007a). These included pending salaries, Bank of Nauru checks, the treatment of the Refugee Processing Center, large subsidies to government-owned business enterprises, large numbers of redundancies in the public sector, and gaps in the statistical collection. In fact, apart from the budget documents for recent years, there are no economic statistics for Nauru.

The only details available on the GDP calculations are the brief general explanation in ADB (2007a): "GDP estimates have been compiled by industry using a mixture of the income and production approaches. Using the income approach, GDP is equal to compensation of employees plus gross operating surplus plus taxes on production and imports less subsidies. Using the production approach, GDP is equal to output less intermediate consumption."

Alternative Estimate of Fishing Contribution to GDP

Table 7.4 represents an alternative to the above method of estimating fishing contribution to GDP in Nauru. It is a simple production approach that takes the values of five types of fishing and aquaculture activities for which production values were determined above (summarized in Table 7.2) and determines the value added by using VARs characteristic of the type of fishing concerned. Those VARs were determined by knowledge of the fisheries sector and by use of specialized studies (Appendix 3).

The approach in Table 7.4 does not intend to replace the official methodology, but rather the results obtained can serve as a comparator to gain additional information on the appropriateness and accuracy of the official methodology—and possibly a need for modification.

Table 7.4 was constructed using the values of production from Table 7.2, which is nominally for 2007. Those values, however, are crude estimates and are likely to be equally applicable to 2006.

The 2007 fishing contribution to GDP in Table 7.4 (A$1,320,900) is considerably less than the fishing contribution estimated by ADB (2007a) of A$2,900,000 (Table 7.3). Given the lack of details on the ADB methodology, it is difficult to explain why the difference is so great, other than simply stating that, if the ADB estimate used the production approach to estimate the fisheries sector contribution, the gross value of production from coastal fisheries in the two studies must be very different.

Table 7.4: Fishing Contribution to Mid-2000s GDP Using an Alternative Approach

Harvest Sector	Gross Value of Production (A$, from Table 7.2)	Value-Added Ratio	Value Added (A$)
Coastal commercial	1,000,000	0.60	600,000
Coastal subsistence	787,000	0.90	708,300
Offshore locally based	0	0	0
Freshwater	0	0	0
Aquaculture	18,000	0.70	12,600
Total			**1,320,900**

A$ = Australian dollar, GDP = gross domestic product.

Sources: From Table 7.2 and consultant's estimates.

Export of Fishery Products

There were high aspirations for fishery exports from Nauru. Chapman (2004) stated that the Nauru Fishing Corporation (NFC) operated the fish market, and had freezers and storage for exporting products. NFC purchased an 18-meter tuna longliner in 2000 and a 15-meter longliner in 2002 to fish for both the local and export market.

Currently, Nauru has no fishery products for export. The last export shipment of fresh tuna from the domestic longline operation was in 2001, and only seven shipments were ever made. Although fish was of good quality and received a good price at auction in Japan, the local longline operation was unprofitable for various reasons, including frequent mechanical problems and lack of incentives in the wage-structure (Philipson 2007b).

Government Revenue from Fisheries

Access Fees for Foreign Fishing

Nauru's national report to the 4th meeting of the Scientific Committee of WCPFC in 2008 gave the numbers and nationalities of vessels authorized to fish in Nauru's EEZ (Table 7.5).

Table 7.5: Foreign Fishing Vessels Authorized to Fish in the Nauru Exclusive Economic Zone

Nationality of Registration	Number of Vessels
People's Republic of China	10
Federated States of Micronesia	4
Japan	33
Kiribati	1
Korea, Republic of	27
Marshall Islands	5
New Zealand	3
Taipei,China	33
United States	9
Vanuatu	6
Total	**131**

Source: Anon (2008b).

Table 7.6: Access Fee Payments to Nauru

Period	Amount (A$)
FY2004	4,582,000
FY2005	not available
FY2006	3,890,000
FY2007	5,100,000
FY2008	6,126,000
FY2009 *estimated*	4,695,000

A$ = Australian dollar, FY = fiscal year.

Source: Nauru Fisheries and Marine Resources Authority, unpublished data.

Table 7.7: Access Fees as a Percentage of Catch Value

Item	2005	2006	2007
"In-zone" value total catch (A$, from Table 7.1)	56,391,963	66,989,650	95,201,620
Access fees (A$, from Table 7.6)	3,890,000	5,100,000	6,126,000
Access fees as percentage of catch value	6.9	7.6	6.4

A$ = Australian dollar.

Source: Forum Fisheries Agency (2008), with modifications by consultant.

These foreign vessels, all purse seiners, pay access fees to Nauru. The amount of those fees in recent years is given in Table 7.6.

The total government revenue was A$24,248,000 in FY2007 and A$35,518,000 in FY2008 (Keke 2008). Access fees represented 21.0% of government revenue in FY2007 and 17.2% in FY2008.

Fishing access fees represented about 8% of the value of the catch taken from Nauru waters of A$50 million–A$80 million/year (ADB 2007a). Table 7.7 makes a similar comparison with data from the present study. Two features should, however, be noted: (i) the catch value is the "in-zone" value, whereas some studies use landed value in destination market country; and (ii) the table compares fees from fiscal years with catch values from calendar years.

Other Government Revenue from Fisheries

Disaggregated information is not available on Nauru government revenue from fisheries that is not associated with access by foreign fishing vessels. The Fisheries Advisor to the Government indicates that transshipment of fish occurs sporadically in Nauru, but there were no such activities (and no fees paid by transshipping vessels) in FY2008 (T. Adams, personal communication, November 2008).

Employment

Following are the results of fisheries-focused socioeconomic surveys carried out in 11 of the 14 districts in Nauru in October and November 2005 (COFISH 2005):

- Total resident population was estimated at 10,131 people and 1,230 households.
- Of 245 households surveyed for income and expenditure, 97% were found to be engaged in fishing activities.
- A total of 405 finfish fishers (357 men and 48 women) and 283 invertebrate fishers (149 women and 134 men) were interviewed. Survey results indicated an average of 3.7 fishers per household; or a total of 4,513 fishers—2,947 men and 1,566 women.
- The main source of income was government employment (86%), with some people employed in the private sector.
- Fisheries do not play a significant role in income for households. For 5%, it is their first income and for 17%, their second income.

Based on the above survey and experience on Nauru, the government Fisheries Advisor made a preliminary estimate that there were about 200 full-time fishers in the country (T. Adams, personal communication, November 2008).

Due to economic crisis at the beginning of the decade, there has been a dramatic increase in reef fishing, gleaning, and collecting (COFISH 2005). In addition, fishing activity among Nauruans is likely to increase following the repatriation of I-Kiribati and Tuvaluan expatriate workers. Previously, following the winding down of mining operations, most fishing activity was carried out by I-Kiribati and Tuvaluan nationals. Generally, Nauruans and other nationals bought fish from the I-Kiribati and Tuvalu fishers and garden fresh produce from non-specified ethnic Chinese, but with the repatriation of I-Kiribati and Tuvaluan workers and with the increasing number of Chinese also leaving the island, this is changing. Nauruans can no longer depend on expatriate workers to supply fish and garden produce and are themselves going out to gather food through traditional work, such as fishing (Dame 2006).

Other available information on fisheries employment in Nauru is as follows:

- NFMRA employs a significant number of people. According to the Fisheries Advisor, in FY2009 there were 56 filled positions and 7 vacancies, down from 80 in 2006. (T. Adams, personal communication, November 2008).
- The fishing fleet in February 2008 consisted of 40–50 motorized skiffs, with only about 20 used regularly; and around 70 actively-used fishing canoes (Blanc and Templeton 2008).
- Milkfish farming in 2006 provided livelihoods for about 30 people (T. Adams, personal communication, November 2008).
- Activities carried out by women in the marine sector tend to differ depending on the ethnic background of the individual (Tuara 1998). The participation of non-Nauruans in fishing and post-harvest activities has changed remarkably in recent years (Dame 2006).

Employment in tuna fishing in recent years is shown in Table 7.8.

Table 7.8: Local Employment in the Tuna Industry

Item	2002	2006	2008
Local jobs on vessels	5	0	0
Local jobs in shore facilities	10	2	0
Total	**10**	**2**	**0**

Source: Gillett (2008).

Fish Consumption

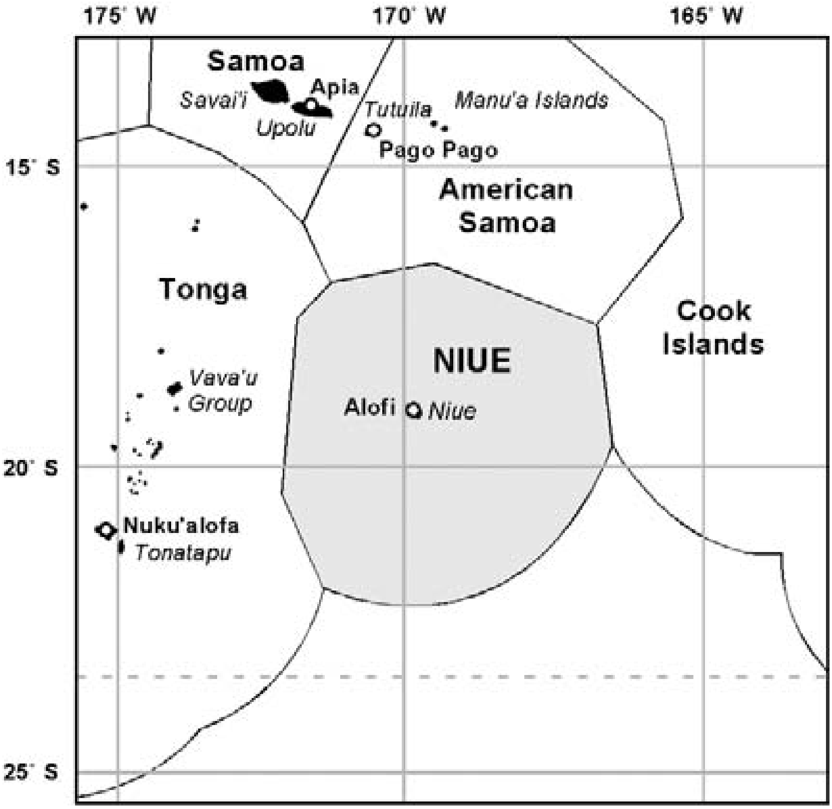
Annual per capita consumption of fishery products in Nauru in late 1990s was estimated at 46.7 kg (Gillett and Lightfoot 2001). According to many studies, consumption of fishery products in Nauru has changed considerably since then.

The SPC/COFISH study in Nauru in October and November 2005 surveyed 245 households and estimated per capita consumption of fresh fish at 46.5 kg/year. Finfish were consumed at an average of 3.8 times a week, while invertebrate consumption was about twice a month. Canned fish was frequently consumed, an average of 2.4 times a week for most households and per capita consumption per year of about 16 kg, or about one-third of fresh fish consumption. For many families, canned fish was an affordable substitute and could be cooked as soup and in many other ways to feed large families. The low consumption of invertebrates could be due to overexploitation. There was very high reliance on fresh fish, with many households interviewed consuming their own catches or buying fish from or being given fish by relatives and neighbors.

Annual per capita fish consumption (whole weight equivalent), according to information from HIES conducted in 2006, was 55.8 kg, of which 96% was fresh fish (Bell et al. 2009).

Food security has emerged as a serious issue due to policy failure and chronic economic decline, which have resulted in total regression of development, with people resorting to basic subsistence fishing and farming for survival. Men, women, and children forage on reefs and hunt birds (primarily the black noddy tern *Anous minutus*) daily for food. Families have resorted to extended family systems to barter wild food for imported food items. These activities are indicative of a situation completely opposite to the common trend of the shift from traditional to imported foods (COFISH 2005).

Niue



Source: Secretariat of the Pacific Community.

Fish Production

Coastal Commercial Catches

Existing information on Niue's coastal fisheries is scattered through several documents. The Niue Department of Agriculture, Forestry and Fisheries (DAFF) has historically used the figure of 120 tons (t) as the annual production from all Niue fisheries. Others have made similar estimates, as follows:

- 100–150 t, about 50% from the reef and 50% from "beyond the reef" (McCoy 1990);
- about 115 t/year, with an additional 4.9 t/year exported to New Zealand during periods of direct air connections, based on information from a Secretariat of the Pacific Community (SPC) nutrition survey carried out on Niue in 1978 (Dalzell et al. 1993);
- commercial fisheries production of 12 t worth $54,720 in 1990 (Dalzell et al. 1996); and
- coastal commercial catch in late 1990s of 12 t worth NZ$96,000 (Gillett and Lightfoot 2001).

Based on published (Anon 2002) and unpublished data from the Statistics and Demography Programme of the SPC and from a household income and expenditure survey (HIES) conducted in 2002, NZ$269,257 was spent by Niue residents to purchase fish (some of which was imported); subsistence fish valued at NZ$535,350 were consumed by Niue residents (all from domestic consumption); and 17 households had "fish income." Using the value of subsistence production in Lewington (2000) adjusted for price changes (adjusted price = NZ$6/kg), there was about 3 t of commercial fish (some of which was imported). There is, however, some evidence from the present study that data from HIES may underestimate fisheries production.

The population of Niue decreased by 17% between 2000 and 2007 (SPC 2008a and Statistics Niue website).

A marine baseline survey was carried out in 2004 (Fisk 2004). This survey largely focused on underwater monitoring and did not make new fisheries production estimates.

Discussions with the Director of Niue's DAFF (B. Pasisi, personal communication, December 2008) gave some insight into coastal fisheries production in Niue:

- No attempts were made to estimate fisheries production for coastal fisheries in Niue since that of Gillett and Lightfoot (2001).
- The DAFF still uses 120 t as the production figure from all coastal fisheries in Niue.
- The coastal fisheries production situation has not changed remarkably in the last decade, but there is one factor that may have had some temporary influence. Local sales from the offshore longliners in 2005–2007 resulted in some reduction in commercial fishing from skiffs.
- Prices paid to fishers in 2007 averaged NZ$7–NZ$9/kg of fish.

Selectively using the above information, the coastal commercial fisheries production in Niue in 2007 is estimated to be 10 t valued at NZ$80,000.

Coastal Subsistence Catches

Annual production in 1990 from subsistence fisheries was estimated at 103 t worth $471,504 (or about NZ$7.64/kg) (Dalzell et al. 1996). A survey in June 2000 during work to compile the national accounts indicated that the annual subsistence catch was about 194 t worth NZ$315,640 (Lewington 2000). The latter estimate was used by Gillett and Lightfoot (2001).

However, using the more recent information in the section above, coastal subsistence fish catch in Niue in 2007 is estimated to be 140 t.

Lewington (2000) followed national accounting conventions and valued subsistence production based on the local market price, which was subsequently discounted by 20%–30%, being an allowance for getting the product to market. The adjusted prices used in Lewington (2000) were NZ$5–NZ$7/kg for most species sold. These prices were thought to be valid for 2007. Accordingly, the 140 t of subsistence fisheries production in 2007 was worth NZ$840,000.

Locally Based Offshore Catches

At the beginning of 2005, Niue began licensing longline vessels to fish under a charter arrangement (Tafatu 2006). The vessels, 10–29 meters in length, supplied the new government joint-venture fish processing facility, Niue Fish Processors Ltd. In 2006, 13 longliners were based in Niue. The Director of Niue's DAFF indicated that production from the boats reached a maximum in 2006 and early 2007. Fishing operations stopped in December 2007.

Estimates of catches of the four main commercial species of tuna in the Western and Central Pacific Fisheries Commission (WCPFC) area during 1997–2007 were made by the Forum Fisheries Agency (FFA 2008), using data sourced from the Oceanic Fisheries Programme of the SPC. The chartering arrangements used for Niue's locally based offshore fleet (i.e., use of vessels registered in French Polynesia and Cook Islands) precluded identifying the catches of the vessels based in Niue.

Tafatu (2006) gave the catches for "Niue's fleet" of 12 longliners in 2006 at 320 t. Close inspection of the data reveals that the 320 t is for only six of the vessels in the fleet. For lack of better data, it will be assumed that the total longline catch for the 12 vessels in 2006 is twice that given in Tafatu (2006), 640 t. This estimate is supported by unpublished data from Customs Niue that showed 602.2 t of fishery exports in 2007, assuming that exports plus local consumption would be close to 640 t.

The value per kg assigned to this offshore catch is that given in FFA (2008) for destination markets, less 15% for transportation to those markets.

For the purpose of the present study, it is estimated that the 2006 and 2007 catches by Niue-based offshore fishing vessels were about 640 t annually worth NZ$2,508,000.

Foreign-Based Offshore Catches

Since 2003, there has been no authorized foreign fishing in Niue's EEZ. US purse seiners are authorized under a multilateral treaty to fish in the Niue, but fishing in Niue waters by those vessels has not occurred in many years.

Freshwater Catches

There are no freshwater fisheries in Niue. The Director of Niue's DAFF (B. Pasisi, personal communication, December 2008) indicates that neither tilapia nor *Macrobrachium* are caught in Niue.

Aquaculture Harvests

There is no aquaculture activity in Niue. Although there has been past enthusiasm for culturing a number of species (trochus, giant clams, pearl oysters, freshwater prawns), this has not been realized.

Summary of Harvests

From the above sections, a crude approximation of annual production and dockside and/or farm-gate value in 2007 was made (Table 8.1). The weak factual basis for all the estimates in the table should be recognized.

Table 8.1: Annual Fisheries and Aquaculture Harvest in Niue, 2007

Harvest Sector	Quantity (t)	Value (NZ$)
Coastal commercial	10	80,000
Coastal subsistence	140	840,000
Offshore locally based	640	2,508,000
Offshore foreign-based	0	0
Freshwater	0	0
Aquaculture	0	0
Total	**790**	**3,428,000**

NZ$ = New Zealand dollar, t = ton.

Source: From production data and consultant's estimates.

Contribution of Fishing to GDP

Current Official Contribution

Lewington (2004a) presented gross domestic product (GDP) estimates for Niue for the years ending in June 1999 to 2003 (FY1999–FY2003). The estimates were in the form of measures of current price contributions by ownership and by industry group. On fishing, the report was only disaggregated to the level of "agriculture, hunting, fishing, and forestry." Unpublished Statistics Niue data provided the fishing contributions (Table 8.2).

Table 8.2: Fishing Contribution to Niue's GDP (current prices, NZ$'000)

Item	FY2000	FY2001	FY2002	FY2003
Fishing contribution	679.3	719.3	723.0	736.6
GDP current prices	16,800.0	16,606.0	16,163.0	17,341.0
Fishing share of GDP (%)	4.0	4.3	4.5	4.2

FY = fiscal year, GDP = gross domestic product, NZ$ = New Zealand dollar.

Sources: Lewington (2004a) and Statistics Niue, unpublished data.

Method Used to Calculate Official Fishing Contribution to GDP

For the subsistence estimates of contribution to GDP by agriculture, fishing, and hunting and gathering, the information came from an informal survey of

25 households in 2002 (Lewington 2004a). This has been supplemented by the September 2002 household survey and an informal enquiry of those in the statistics and customs offices on changes in recent years.

For estimating the contribution of fishing to GDP, a worksheet for calculating the value added from "productions for own use and local sale of crops, fishing and hunting" partitions the fishing sector into six components: wahoo, skipjack tuna, bonita, other ocean fish, reef fish, and coconut crabs. For each of these, the following is determined: amount consumed per Niuean and Palangi household per week, price per unit, gross value of consumption per week, cost of production excluding labor per week, and contribution to value added per year.

The methodology seems logical and was devised by an individual with substantial experience in national accounts in several Pacific island countries. The precision of the estimate is obviously highly dependent on the accuracy of the HIES and the "informal survey," something that is difficult to determine without intimate knowledge of the details of those studies. On the lack of inclusion of harvests from reef gleaning, many studies of Niue fisheries (e.g., Dalzell et al. 1990; Dalzell et al. 1993; Tuara 2000) stressed the importance of this type of fishing. A minor point is having both skipjack and "bonita" categories.

Alternative Estimate of Fishing Contribution to GDP

Table 8.3 presents an alternative to the official method of estimating the contribution of fishing to GDP. It is a simple production approach that takes the values of five types of fishing and/or aquaculture activities for which production values are summarized in Table 8.1. The alternative approach also determines the value added by using VARs characteristic of the type of fishing concerned. The VARs were determined by knowledge of the fisheries sector and by use of specialized studies (Appendix 3).

The approach in Table 8.3 does not intend to replace the official methodology, but rather the results obtained can serve as a comparator to gain additional information on the appropriateness and accuracy of the official methodology—and possibly a need for modification.

The estimates of annual gross values of production in the categories of coastal commercial and coastal subsistence in the table are crude, and are likely to be similar for 2003. In 2003, no offshore locally based fishing was conducted in Niue. Fishing contribution to GDP in 2003 is therefore estimated to be NZ$766,000 (NZ$52,000 plus NZ$714,000). This is about 4% greater than the official fishing contribution for 2003 (Table 8.2).

Table 8.3: Fishing Contribution to Niue's GDP in 2007 Using an Alternative Approach

Harvest Sector	Gross Value of Production (NZ$, from Table 8.1)	Value-Added Ratio	Value Added (NZ$)
Coastal commercial	80,000	0.65	52,000
Coastal subsistence	840,000	0.85	714,000
Offshore locally based	2,508,000	0.20	501,600
Freshwater	0	0	0
Aquaculture	0	0	0
Total			**1,267,600**

GDP = gross domestic product, NZ$ = New Zealand dollar.

Sources: Table 8.1 and consultant's estimates.

Export of Fishery Products

Frozen albacore was exported to the two canneries in Pago Pago, American Samoa, with small quantities of fresh bigeye and yellowfin tuna being exported to New Zealand, US, and Japan. The export fish is mostly whole sashimi with loins (Tafatu 2006).

Unpublished data from Customs Niue indicated that fish exports were 88.5 t in 2005, 403.6 t in 2006, and 602.2 t in 2007. The provisional 2007 export data suggested that fishery exports made up over 90% of the value of all exports (J. Tamate, personal communication, October 2008).

Government Revenue from Fisheries

Access Fees for Foreign Fishing

Since 2002, Niue has not received access fees from foreign longline fishing operations (Tafatu 2006). The locally based longline fishing is a 50/50 joint venture between the Government of Niue and a foreign partner, and no access fees are paid (B. Pasisi, personal communication, December 2008).

Under the terms of the US multilateral tuna treaty, Niue and other Pacific island countries receive payments from the Government of the United States and the US tuna industry that are associated with fishing access by US purse seiners. Table 8.4 gives the funds received by Niue from the treaty for the past five years.

Table 8.4: Payments to Niue from the US Multilateral Treaty ($)

Licensing Period	15% Shares[a]	85% Shares[b]	PDF Shares[c]
20th Period 15 June 2007 to 14 June 2008	145,860.78	0.00	111,125.00
19th Period 15 June 2006 to 14 June 2007	145,860.78	0.00	111,125.00
18th Period 15 June 2005 to 14 June 2006	147,209.70	0.00	111,125.00
17th Period 15 June 2004 to 14 June 2005	147,310.43	0.00	111,125.00
16th Period 15 June 2003 to 14 June 2004	147,357.28	0.00	111,125.00

PAF = Project Development Fund.

[a] The "15% shares" ($ 2,042,050.92 in 2008) are shared equally between all countries that are parties to the treaty.

[b] The "85% shares" ($14,273,117.87 in 2008) are apportioned to countries based on where the catch by US vessels was made. These amounts in the table are zero because US seiners have not attempted to fish in Niue in over 20 years.

[c] The "PDF shares" ($1,555,750.00 in 2008) are shared equally between all countries that are parties to the treaty for project development work.

Source: Unpublished National Marine Fisheries Service (of the United States) public domain data.

Some Pacific island countries consider that all payments under the US treaty are for fishing access, while others treat some components (e.g., the PDF shares) as aid. The Treasury Department (2007) indicated that NZ$382,775 was received in FY2007 for "fishing rights."

Other Government Revenue from Fisheries

Apart from foreign access fees, the governments of other Pacific island countries receive various types of revenue from the fisheries sector, including fish transshipment charges, fees on domestic fishing vessels, and export levies on fishery products. No information is available on the amount of such revenue in Niue, if any.

Employment

The report of the 2002 HIES (Anon 2002) contained information relevant to fisheries employment. The "annual fish income" was estimated to be NZ$28,720, or 0.9% of all income in Niue for the year (NZ$3,281,143). Twelve percent of all households had "fish income." The HIES also stated that 5 people were working for pay in "fishing, fish farms, service activities to fishing," and that all those workers were in the income bracket of NZ$15,000–NZ$19,999.

Table 8.5: Number of Fishing Vessels by Village

Village	Canoe	Aluminum Dinghy	Inflatable Dinghy	Boat	Outboard Motor	Total
Makefu	11	0	0	4	0	15
Tuapa	12	6	0	1	6	25
Namukulu	1	0	1	0	1	3
Hikutavake	6	0	0	0	0	6
Toi	0	0	0	0	0	0
Mutalau	9	1	0	0	1	11
Lakepa	3	2	0	0	3	8
Liku	3	1	0	1	2	7
Hakupu	1	1	0	0	0	2
Vaiea	3	4	0	1	7	15
Avatele	24	10	0	2	9	45
Tamakautonga	11	4	2	0	6	23
Alofi South	29	28	1	12	30	100
Alofi North	9	9	1	2	12	33
Total	**122**	**66**	**5**	**23**	**77**	**293**

Source: Anon (2007c).

According to the 2006 census, there were 293 fishing vessels, shown by village in Table 8.5.

Other available information on fisheries employment in Niue follows.

- In late 2008, there were 5 or 6 people who could be considered full-time commercial fishers, according to the Director of Niue's DAFF (B. Pasisi, personal communication, December 2008). The total labor force of Niue was 1,127 in 2006 (Anon 2006). Thus, the five commercial fishers represented 0.4% of Niue's labor force.
- The joint-venture fish processing, packing, and export plant ceased operating in December 2007. When it was fully operational (late 2006 to late 2007) it employed 5–6 factory floor workers, 1 manager, 3 office staff, and 2 handy men (A. Hamilton, personal communication, December 2008).
- There is no available information on the activities of women involved in fisheries in Niue (Tuara 2000).

Fish Consumption

Estimated annual per capita fish consumption in 1987 was 40.8 kg food weight, or about 49.0 kg whole fish weight, based on a 1987 SPC nutrition study (Dalzell et al. 1993). Gillett and Lightfoot (2001) considered (i) the Niue population of 1,900 people in 2000, (ii) a subsistence fisheries production of 194 t, (iii) a commercial fisheries production of 12 t, and (iv) fishery imports of 20 t, to estimate annual per capita consumption of fishery products on Niue in 2000 at 118.9 kg.

COFISH conducted fieldwork around Niue in May and June 2005. The survey interviewed about half the households and made estimates of fish consumption (Table 8.6).

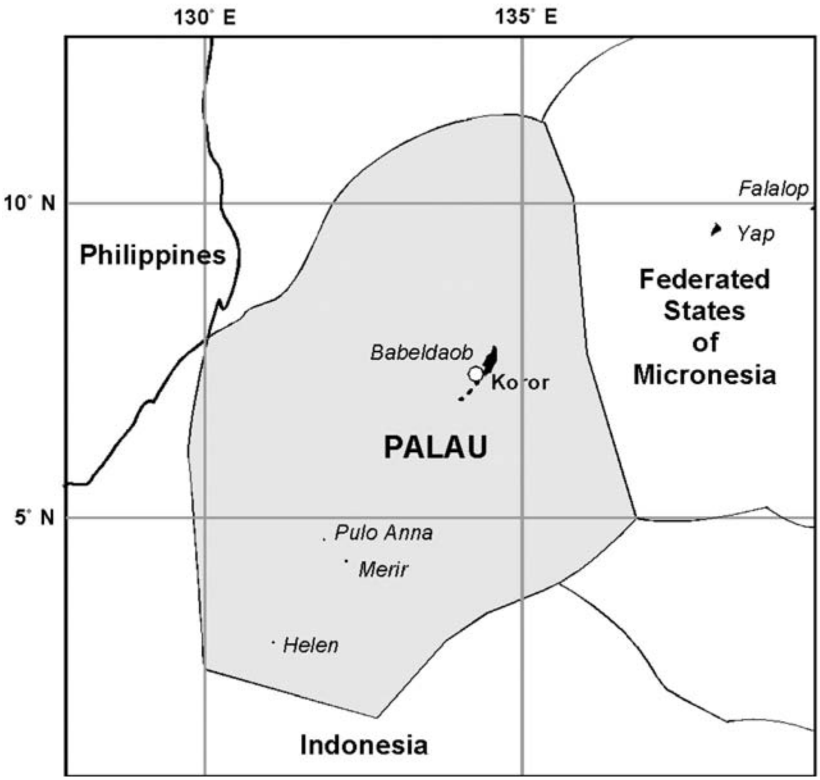
Annual per capita fish consumption in 2002 (whole weight equivalent) was estimated to be 79.3 kg, some of which was imported, based on information from the 2002 HIES (Bell et al. 2009).

Table 8.6: Seafood Consumption on Niue

Item	Consumption/ Frequency
Quantity, fresh fish consumed (kg/capita/year)	31.03 (±2.04)
Frequency, fresh fish consumed (times/week)	1.98 (±0.09)
Quantity, fresh invertebrates consumed (kg/capita/year)	2.53 (±0.33)
Frequency, fresh invertebrates consumed (times/week)	0.54 (±0.05)
Quantity, canned fish consumed (kg/capita/year)	17.17 (±1.26)
Frequency, canned fish consumed (times/week)	2.04 (±0.11)

Source: M. Kronen (personal communication, March 2009).

Palau



Source: Secretariat of the Pacific Community.

Fish Production

Coastal Commercial Catches

Early estimates of coastal fisheries production in Palau were:

- Total inshore catch (including subsistence) of 1,700 tons (t) (Preston 1990).
- "Somewhere between 500 and 1,100 t/year" (Kitalong and Dalzell 1994), based on several estimates of subsistence production in Palau.

- Coastal commercial fisheries production of 736 t worth $2.4 million (Dalzell et al. 1996), based on the 1992 annual report of the Division of Marine Resources.
- Annual average catch for 1989–1998 of 2,115 t (PCS 2000), based on available information on the amount of inshore catch in Palau for 1989–1998 and from individuals familiar with the fishery sector.

Gillett and Lightfoot (2001) concluded that Palau Conservation Society (PCS) (2000) was the most accurate production estimate and partitioned it into coastal commercial and subsistence components of 865 t worth $2,595,000 and 1,250 t valued at $2,500,000, respectively.

A household income and expenditure survey (HIES) was conducted in Palau in May–November 2006 (Alonz 2007). Unpublished HIES data, kindly provided by the Secretariat of the Pacific Community's Statistics and Demography Programme, were used to estimate fish production (Table 9.1), indicating a total annual production of 477 t.

On the above production estimates, a significant proportion of the "tuna" category (and perhaps also the "other fresh and frozen fish") comes not from coastal fisheries but from offshore fishing by the industrial longliners based in Palau. Even if all the tuna and other categories in Table 9.1 are considered to be from coastal fisheries, the total amount (477 t) is less than one-quarter of the highly regarded estimate made by PCS (2000) for the previous decade (2,115 t). Thus, information from the 2006 HIES may greatly underestimate production of both commercial and subsistence fisheries.

Table 9.1: Fish Production Estimated by the 2006 HIES (kg)

Item	Purchased	Caught	Total
Tuna	38,271	21,588	59,859
Flyingfish	113	0	113
Frozen fish	921	0	921
Other fresh and frozen fish	117,179	230,315	347,494
Paua	510	0	510
Mussels	2,939	0	2,939
Octopus, squids	3,258	128	3,386
Seaweed (rimu)	1,939	0	1,939
Other shellfish	23,824	35,893	59,717
Total	**188,954**	**287,924**	**476,878**

HIES = household income and expenditure survey, kg = kilogram.

Note: Canned fish amounts were deleted.

Source: From unpublished data, courtesy of the Secretariat of the Pacific Community's Statistics and Demography Programme.

Interestingly, the ratio between "purchased" and "caught" on the HIES table above is almost identical to the ratio of "coastal commercial" and "subsistence" of the Gillett and Lightfoot (2001) estimate.

The Palau International Coral Reef Center carried out a survey of subsistence fishing in Palau in 2003. There were, however, problems with coding the data and the results have not been analyzed (E. Matthews, personal communication, October 2008).

The Palau Conservation Society conducted a study of subsistence fishing activities in the Rock Islands in 2003 (Matthews 2004). The objective of the study was to gather information on subsistence fishing and marine resource collection activities in Palau's southern lagoon. The estimates of subsistence production were only on quantity per trip. Respondents were asked to estimate the size of typical, bad, and good catches for a trip. The average estimated catches were 95 pounds (43 kg) for typical catch, 65 pounds (31 kg) for bad catch, and 165 pounds (75 kg) for good catch.

Palau's Bureau of Marine Resources (BMR) collects data from local fisheries markets. Over the decades the quality of data has varied and the proportion of market information captured has varied from 30% to 85% (Marino 2008). The larger local markets that are monitored handle only a fraction of the total catch (Anon 2005). Although BMR data do not represent total production, they can provide some insight into changes in production in recent years. These data show that during 2002–2006, the monitored annual catch of "fish and other marine products" remained relatively constant (except for 2005), ranging between 199 t and 217 t (Bureau of Budget and Planning 2008).

Knowledgeable individuals with long involvements in Palau's fisheries provided the following additional information on fisheries production:

- Annual, coastal commercial fisheries production is about 400 t. Visits by fishing operations to the Southwest Islands and to the north result in significant production increases, but these are temporary. Subsistence fisheries production is about three times the coastal commercial amount. With fuel cost increases in recent years, there appear to be more fishers on each motorized fishing boat and a noticeable increase in nonmotorized fishing canoes (A. Kitalong, personal communication, October 2008).
- Changes have been made that would affect coastal fisheries production since the PCS (2000) survey: more tourists from Taipei,China (more large fish for restaurants); construction of the road around Babeldaob Island (changes in distribution of fishing

effort, marketing arrangements); an increase in formal employment (less subsistence fishing); and an increase in fuel cost (less fuel-intensive fishing). Catches for the aquarium fish trade have been variable (E. Matthews, personal communication, October 2008).

The population of Palau increased by about 4% between 1999 and 2007. Recently, a significant number of people moved from the Koror urban area to the more rural Babeldaob after the opening of the new road.

The above information on coastal fisheries production in Palau is equivocal. There is general consensus on the validity of the PCS survey. Since that survey, there have been factors that tend to both increase and decrease fisheries production. For the purpose of the present study, annual coastal fisheries production was assumed to be the same as in PCS (2002), as partitioned by Gillett and Lightfoot (2001) between coastal commercial and subsistence. Coastal commercial production in the mid-2000s is taken to remain at 865 t. At a price to the fisher of $2.87/kg[28], this is worth $2,843,000.

Coastal Subsistence Catches

A subsistence production in 1992 of 750 t worth $1.8 million was estimated by Dalzell et al. (1996). From this and the later information above, the coastal subsistence fish catch in Palau in the mid-2000s was estimated to be 1,250 t. Using the "farm-gate" system of valuing subsistence production (discounting prices for commercial fish by 30%), this was worth $2,511,000 to the producer.

Locally Based Offshore Catches

The number of foreign longliners licensed to fish in the Palau zone was 156 in 2005, 266 in 2006, and 66 in 2007 (Anon 2008c). Catch estimates used here for the Palau-based vessels using available data assumed that all fresh fish longliners (non-freezer longliners) operating in the Palau exclusive economic zone (EEZ) were based in Palau, and that the catch by the single pole-and-line vessel based in Palau was negligible in recent years. Individuals familiar with offshore fishing in the Palau zone believed that these assumptions were

[28] The PCS study used retail prices: "Prices for each product group are presented as local retail prices unless otherwise noted." Gillett and Lightfoot (2001) followed that convention for Palau, hence the relatively high value of their estimated catches.

reasonable (K. Sisior and M. McCoy, personal communication, October 2008).

Estimates of the catches and values of the four main commercial species of tuna in the Western and Central Pacific Fisheries Commission (WCPFC) area for 1997–2007 were made by the Forum Fisheries Agency (FFA) (FFA 2008), using data sourced from the Oceanic Fisheries Programme of the Secretariat of the Pacific Community (SPC). In these data, prices were all "delivered" prices in that they reflected the price received at entry to the country in which they were usually sold whether for processing or consumption. Also, bycatch, which is an important component of locally based offshore longline fisheries, was not included. The FFA data, modified for bycatch and transshipment costs, are given in Table 9.2.

Table 9.2: Catches by the Palau-Based Offshore Fleet[a]

Item	2003	2004	2005	2006	2007
Tuna catch (t)	1,453	1,551	3,159	4,565	2,331
Destination value of tuna catch ($)	9,333,647	10,453,371	22,802,184	32,569,040	16,211,360
Total catch (t)	1,889	2,016	4,107	5,935	3,030
Dockside value of total catch ($)	7,933,600	8,885,365	19,381,857	27,683,684	13,779,656

t = ton.

[a] In the table, the tuna catch is increased by 30% for bycatch. The destination market values are reduced by 25% for transport to those markets and increased by 10% for the sale of bycatch.

Source: Forum Fisheries Agency (2008), modified by the consultant.

Foreign-Based Offshore Catches

Catches of the foreign-based fleet in recent years, modified for bycatch, are shown in Table 9.3, and their values, modified for transshipment costs, are shown in Table 9.4.

Freshwater Catches

No major freshwater fisheries are conducted, but the larger islands of Palau (especially Babeldaob) have freshwater bodies that support edible freshwater fish and invertebrates. Jenkins (1999) reported 47 freshwater fish species, including 4 endemic and 5 introduced. Lake Ngardok in Melekeok State on the island of Babeldaob is the largest lake in Micronesia, with an area of approximately 0.18 km^2. The longest river in Palau, the Ngerdorch River,

Table 9.3: Catches by the Foreign-Based Fleet in the Palau Zone (t)[a]

Item	2003	2004	2005	2006	2007
Purse seine tuna catch	3,364	4,358	1,959	3,969	387
Longline tuna catch	46	40	69	831	814
Total purse seine catch	3,532	4,576	2,057	4,167	406
Total longline catch	60	52	90	1,080	1,058
Total catch of foreign-based offshore fleet	3,592	4,628	2,147	5,247	1,464

t = ton.

[a] In the table, the purse seine tuna catch is increased by 5% for bycatch. The longline tuna catch is increased by 30% for bycatch.

Source: Forum Fisheries Agency (2008), modified by the consultant.

Table 9.4: Catch Value for the Foreign-Based Fleet in the Palau Zone ($)[a]

Item	2003	2004	2005	2006	2007
Destination value purse seine tuna catch	3,156,284	4,107,490	2,357,793	4,794,239	611,729
Destination value longline tuna catch	227,389	200,159	338,753	4,867,925	4,660,554
Local value total purse seine catch	2,682,841	3,491,366	2,004,124	4,075,103	519,970
Local value total longline catch	216,020	190,151	321,815	4,624,529	4,427,526
Total local value foreign-based offshore fleet	2,898,861	3,681,517	2,325,939	8,699,632	4,947,496

[a] In the table, the local value of the purse seine catch is the destination market value, less 15% for sea transport to get to those markets. The local value of the longline catch (all frozen) is the destination value less 15% for sea transport to get to those markets, plus 10% for bycatch sale.

Source: Forum Fisheries Agency (2008), modified by the consultant.

drains from Lake Ngardok and flows 10 km to its mouth in Ngchesar State on the east coast of Babeldaob (Anon 2005).

Bureau of Marine Resources staff indicate that eels and shrimp are the most important edible freshwater animals. The capture of eels is not large due to cultural attitudes. Small amounts of freshwater shrimp are consumed (K. Sisior, personal communication, October 2008).

For the purpose of the present study, annual freshwater fisheries production in recent years is estimated to be 1 t worth $8,000.

Aquaculture Harvests

The Micronesian Mariculture Demonstration Center (later renamed the Palau Mariculture Demonstration Center, PMDC) was established in 1972. For nearly four decades, the culture in Palau of a large number of organisms has been attempted, both at the PMDC and through independent efforts.

Significant aquaculture production in Palau is presently confined to giant clams and milkfish. Giant clams are raised at the PMDC and provided at no cost to grow-out farmers. BMR unpublished data indicated that PMDC gave 245,945 small clams to farmers in 2006, and 109,650 in 2007. About 85% of the clams were exported and 15% were sold to restaurants in Palau (L. Demei, BMR, personal communication, October 2008). CITES (2008) showed that 2,705 giant clams were exported from Palau in 2006 and 2,625 in 2007. Food and Agriculture Organization of the United Nations (FAO) (2008) indicated that $17,000 worth of "mollusks and other aquatic invertebrates" were exported in 2006.

Milkfish are cultured for sale at the Ngatpang state government farm. Production was about 1 t in 2007 (T. Taro, PCC, personal communication, October 2007). These were sold in Koror for $4.40/kg. Peleliu has subsistence milkfish production. In 2007, 1,096 fish were harvested and given to the community (L. Demei, BMR, personal communication, October 2008).

Palau's aquaculture harvest in 2007 is estimated to be 3,100 clams and 2 t of milkfish, with a combined value of $50,000.

It is interesting to note that after 36 years of institutional and financial support from the Palau Mariculture Demonstration Center and assistance from other agencies, there is only a small amount of aquaculture production, mostly (if not entirely) dependent on government subsidies.

Table 9.5: Annual Fisheries and Aquaculture Harvest in Palau, 2007[a]

Harvest Sector	Quantity (t)	Value ($)
Coastal commercial	865	2,843,000
Coastal subsistence	1,250	2,511,000
Offshore locally based	3,030	13,779,656
Offshore foreign-based	1,464	4,947,496
Freshwater	1	8,000
Aquaculture	3,100 pieces plus 2	50,000
Total	**3,100 pieces plus 6,612 t**	**$24,139,152**

t = ton.

[a] The values in the table are dockside and/or farm-gate prices, except in the case of offshore foreign-based fishing where the value in local waters (overseas market prices less imputed transshipment costs) is given.

Source: Consultant's estimates.

Summary of Harvests

From the above sections, a crude approximation of annual production and value in 2007 was made (Table 9.5). The estimates are judged to be fairly accurate, relative to those in this study from other Pacific island countries.

Contribution of Fishing to GDP

Current Official Contribution

The official contribution of "fisheries" to GDP, from the national accounts, is given in Table 9.6.

Table 9.6: Nominal GDP of Palau ($'000)

Item	2003	2004	2005	2006
"Fisheries" component of GDP	2,630	2,788	3,124	3,383
Palau GDP	122,728	133,560	145,428	156,614
Fisheries as a percentage of Palau GDP	2.1	2.1	2.1	2.2

GDP = gross domestic product.

Source: Bureau of Budget and Planning (2008); GDP is for the calendar year (not fiscal year).

Method Used to Calculate Official Fishing Contribution to GDP

Staff of the Office of Planning and Statistics kindly provided some information on calculating the "fisheries" contribution to GDP—but stressed that they were not intimately familiar with the details (M. Hangaripaii, personal communication, October 2008). They stated that the present method is a hybrid between the income and the expenditure approach to GDP calculation. The 2005 census provided information on the number of small-scale commercial fishers; the 2006 HIES provided information on subsistence activities; the Social Security System provided information on income; and a corporate survey provided information on company production.

Some uncertainty exists among the Planning and Statistics staff on how much, if any, nonfishing activity is included in the "fisheries" category (i.e., fishing versus fisheries). Given the level of detail available, little comment can be made on the methodology.

Alternative Estimate of Fishing Contribution to GDP

Table 9.7 presents an alternative to the official method of estimating fishing contribution to GDP in Palau. It is a simple production approach that takes the values of five types of fishing/aquaculture activities for which production values were determined and summarized in Table 9.5 above. The approach also determines the value added by using VARs characteristic of the type of fishing concerned. The VARs were determined by knowledge of the fisheries sector and by use of specialized studies (Appendix 3).

The approach in Table 9.7 does not intend to replace the official methodology, but rather the results obtained can serve as a comparator to gain additional information on the appropriateness and accuracy of the official methodology—and possibly a need for modification.

Table 9.7 uses the specific value of production of the locally based offshore fleet in 2006 (Table 9.4). The other values of production are the general "mid-2000s" values determined in the sections above.

Table 9.7: Fishing Contribution to GDP Using an Alternative Approach, 2006

Harvest Sector	Gross Value of Production ($, from Table 9.5)	Value-Added Ratio	Value Added ($)
Coastal commercial	2,843,000	0.70	1,990,100
Coastal subsistence	2,511,000	0.80	2,008,800
Offshore locally based	27,683,684	0.20	5,536,737
Freshwater	8,000	0.95	7,600
Aquaculture	50,000	0.60	30,000
Total			**9,573,237**

GDP = gross domestic product.

Sources: Table 9.6 and consultant's estimates.

The total value added from fishing in Table 9.7 ($9.6 million for 2006) is considerably greater than the 2006 official estimate for "fisheries" of $3,383,000. Without more details on the methodology or more disaggregation of the "fisheries" sector, it is not possible to identify where the major difference lies. One possibility is the use of the HIES in the official methodology to estimate subsistence fisheries production. As noted above, the 2006 Palau HIES may have significantly underestimated coastal fisheries production.

Export of Fishery Products

Tuna make up most of the exports of fishery products from Palau. All fresh, chilled sashimi-grade tuna, once offloaded and packed, is air-freighted within 24 hours to sashimi markets, with 95% going to Japan and the remainder to the US mainland and Taipei,China (Anon 2008c). Table 9.8 gives recent annual exports of tuna from Palau. Information on the value of the exported tuna is unavailable. From information in FFA (2008), it is estimated that in 2007 the total free-on-board (FOB) export value of tuna was about $19 million.

Non-tuna fishery exports for 2005 and 2006 are shown in Table 9.9. Information on the total exports of Palau is not readily available.[29] The International Monetary Fund (IMF) (2006) stated that 100% of the exports of Palau in recent years were fish.

Table 9.8: Annual Export of Tuna from Palau (kg)

Year	Total Cannery Tuna	Total Sashimi Tuna	Total Tuna Exports
2001	234,343	1,810,295	2,044,638
2002	135,303	1,214,177	1,349,480
2003	155,251	1,650,553	1,805,804
2004	627,351	2,122,688	2,750,039
2005	429,332	3,257,465	3,686,797
2006	844,671	4,823,594	5,668,265
2007	652,977	3,346,257	3,999,234

kg = kilogram.

Source: Bureau of Marine Resources, unpublished data.

Table 9.9: Non-Tuna Exports of Palau ($'000)

Item	2005	2006
Ornamental fish nei	62	65
Miscellaneous corals and shells	0	19
Mollusks and other aquatic invertebrates, live, fresh, or chilled, not elsewhere included	17	17
Coral and the like	241	8
Total	**320**	**109**

nei = not elsewhere included (in the FAO export database).

Source: FAO (2008).

29 An international trade section is not included in the latest statistical yearbook (2006) and the "merchandise trade" page of the Office of Planning and Statistics website is not functional.

Government Revenue from Fisheries

Access Fees from Foreign Fishing

Currently, there are four arrangements by which Palau receives payment for foreign fishing in its waters:

- **Locally Based Foreign Fleet.** There are three locally based fishing companies which have been operating for some years: Palau International Traders Inc., Palau Marine Industries Corp., and Kuniyoshi Fishing Co. Normally more than 100 longline vessels are licensed each year (DevFish 2006).
- **Japanese agreement.** This agreement covers three types of tuna fishing by vessels based in Japan: longline, pole-and-line, and purse seine. In its present form, the agreement has been in effect since 1992, with minor changes. However, there has been no Japanese pole-and-line fishing in Palau waters since 1994 and no purse seine fishing since 1999 (M. McCoy, personal communication, November 2008).
- **FSM Arrangement.** This treaty between participating Pacific island countries allows access on favorable conditions to fishing zones by purse seiners registered in those participating countries.
- **US Treaty**. Under the terms of the US multilateral tuna treaty, Palau and other Pacific island countries receive payments from the Government of the United States and the US tuna industry that are associated with fishing access by US purse seine vessels. Some Pacific island countries consider that all payments under the US treaty are for fishing access, while others treat some components as aid.[30]

Recent annual payments received by Palau under these four arrangements are given in Table 9.10. The $1.1 million received for foreign fishing access in 2007 represented about 3% of the total domestic revenue of $35.5 million of the Government of Palau for FY2007, or about $55 for each of the 20,162 residents of Palau.

[30] In Table 9.10, the amounts listed treat all fees as access fees.

Table 9.10: Summary of Foreign Fishing Access Fees ($)

Year	Locally Based Foreign Fleet	Japan	FSM Arrangement	US Treaty[31]	Total
2004	297,500	273,340	65,454	492,878	1,129,171
2005	428,000	225,924	0	258,435	912,360
2006	694,500	261,525	0	258,335	1,214,360
2007	495,000	369,296	0	256,986	**1,121,281**

FSM = Fedrated States of Micronesia, US = United States.

Source: Bureau of Marine Resources unpublished data, Bureau of Budget and Planning (2008), National Marine Fisheries Service (of the United States) unpublished public domain data.

Other Government Revenue from Fisheries

The other significant source of direct government revenue from fisheries activities is the fish export tax. During 1999–2007, the government imposed a tax of $0.25/kg of fish landed by longliners in Palau, irrespective of quality or marketing destination (i.e., sashimi grade for air export, bycatch species and reject tuna, for local sale or export). In 2008, the tax rate was increased to $0.35/kg.

Unpublished data from the Bureau of Budget and Planning shows the total amounts collected from the fish export tax: FY2005, $882,000; FY2006, $1,471,000; and FY2007, $1,002,000. A fishing company estimated that a fleet of 120 longliners based in Koror would produce $6.6 million in direct government revenue, including $2.5 million from fish export taxes and $1.7 million from fuel taxes (J. Rui, personal communication, March 2009).

Employment

The 2005 census contains some information on employment in fisheries (Office of Planning and Statistics 2005). Unfortunately, much of the employment-relevant data are aggregated with jobs from other sectors. For example, 559 people in 2005 had the occupation of "farming, forestry, and fishing." However, the census noted that of the 13,800 people reporting income in 2004, 305 people (2.2%) reported income from selling fish; and of 14,154 people over 18 years old in 2004, 933 people (6.6%)—of whom 186 (19.9%) were female—reported some subsistence fishing activity (defined in the census as mainly producing goods for his/her own or family's use and needs).

[31] The licensing periods for the US treaty are from July to June. In the table, the treaty fees are treated as though they were received in the second part of the year (e.g., the 2006/07 treaty payments are listed under 2007).

Results of the 2003 study of subsistence fishing activities in the Rock Islands by the Palau Conservation Society (Matthews 2004) indicated that 82% of the subsistence fishers interviewed were male. The age of fishers was 15–86 years, with 44.4 years as the average. Most of the respondents (97%) indicated that they fish and collect for their families; more than half (58%) collect for customs; and just over half (53%–56%) sell a portion of their catch.

For coastal commercial fishing, PCS (2000) reported that there were 200 commercial and 1,100 noncommercial fishers in Palau in late 1990s. With a gradual movement of people out of fishing and into tourism, the number of commercial fishers has decreased since then (A. Kitalong, personal communication, October 2008).

Table 9.11: Employment in the Tuna Fisheries of Palau

Item	2002	2006	2008
Local jobs on vessels	1	0	0
Local jobs in shore facilities	11	5	20
Total	**12**	**5**	**20**

Source: Gillett (2008).

The number of people employed in the larger-scale offshore tuna fisheries (fishing and postharvest) in recent years is shown in Table 9.11.

Fish Consumption

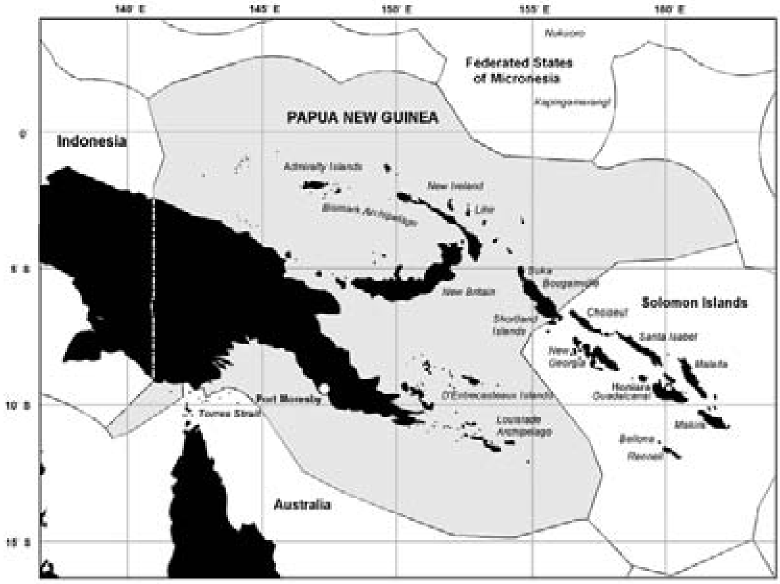
Annual per capita fish consumption in Palau in 1995 was estimated at 85.0 kg by Preston (2000), using FAO production, import, and export data.

Average annual per capita fish consumption in 2006 was estimated at 33.4 kg (whole weight equivalent), of which 78% was fresh fish. Using information from the 2006 HIES, Bell et al. (2009) estimated the per capita consumption of fish at 43.3 kg for rural areas and 27.8 kg for urban areas. Reservations about the accuracy of the 2006 Palau HIES were noted above.

For the 1990s, annual local coastal production was estimated at 2,115 t, fishery product imports at 610 t, and fishery product exports of 400 t. During this period, the mean resident population in Palau was 16,600 with annual visitors to Palau (full-time resident equivalents) of 500 (PCS 2000). This equated to annual per capita fishery product consumption of 135.0 kg.

The mid-2007 population of Palau was 20,162 (SPC 2008a); in 2007, "local sales and donations" of tuna and billfish from the locally based longline fleet were 216,789 kg (BMR unpublished data). Thus, annual per capita fishery product consumption in 2007 (whole fish equivalent) was 123 kg.

Papua New Guinea



Source: Secretariat of the Pacific Community.

Fish Production

Coastal Commercial Catches

Annual production from coastal commercial fisheries[32] in Papua New Guinea (PNG) was estimated at 4,966 t worth $22,096,908, by Dalzell et al. (1996), using information from late 1980s and early 1990s. Annual production in the mid-1990s was estimated at about 4,800 t worth K16.4 million (Preston 1996a). For 1989 to 1991, annual commercial production was estimated at 5,500 t worth K55 million (Gillett and Lightfoot 2001).

There has been no recent research geared at assessing the total production of PNG's coastal commercial fisheries. Consequently, the method used here was to extrapolate previous estimates considering recent changes in production of some of the important coastal commercial fisheries. Information from NFA (2008), GPA (2006), Diffey (2005), FAO (2008), staff of the National

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32 Prawn (shrimp) and lobster fisheries are considered "coastal commercial fisheries" in this section.

Fisheries Authority (NFA), and discussions with knowledgeable individuals suggests that over the decade to 2008,

- production of bêche de mer gradually decreased but showed a net increase in value, although it did reach a historical high of 679 t in 2006 (worth K37 million);
- the lobster fishery showed little net change in catch but a gradual increase in price;
- prawn or shrimp, annual fisheries production was typically 400–1,300 t. About 600 t of prawns worth about $4 million were exported in 2004, but catches have since declined significantly;
- fisheries for trochus and pearl shell have been relatively stable in quantity but increasing in value;
- fishing for coastal reef fish and deep water snapper as an artisanal activity has declined, at least partially due to the inefficient petrol-driven boats used in the fishery, fuel cost increases, and markets;
- coastal fisheries projects funded by international organizations and those by the government all collapsed when the subsidies stopped; and
- artisanal shark fishing for fins became very significant, but difficult to differentiate in statistics from those caught by the offshore fleet.

It should be noted that the prices and values above were a mixture of prices paid to fishers, retail market prices, and export prices. By discounting retail and FOB export prices by 30%–40%, prices paid to fishers were approximated to provide more comparable standard prices in this study.

Using the above information, it was estimated that the coastal commercial production in the mid-2000s was 5,700 t worth K80 million to the producer.

Coastal Subsistence Catches

The three recent estimates of annual, coastal subsistence catches in PNG that are often cited are

- 20,588 t worth $41,176,000 in late 1980s and early 1990s (Dalzell et al. 1996);
- 26,000 t (Preston 1996a); and
- 26,000 t worth K52 million in late 1990s (Gillett and Lightfoot 2001).

Additional information has since become available. The population of PNG increased 16% between the latest estimate above and mid-2006. In addition, a new study has given more insight. PNG's annual household fish production in 1996 was estimated by Gibson (2000), using a 1996 PNG household survey, to be 50,000 t (± 12,000 t) worth K60 million (± K17 million). This apparently includes the subsistence fish catch in freshwater (covered in a later section).

Coastal subsistence production (coastal plus freshwater) in 2006 was estimated here by updating the Gillett and Lightfoot (2001) estimate to account for the 16% population increase and by expanding the mid-1990s estimates of freshwater subsistence production (13,500 t [Preston 1996a]) by 30% for population increase and for the effects of stocking (Coates 1996), giving a total of 47,500 t, which is within the range of the Gibson (2000) study.

Assuming an average fish price in nonurban markets of K5/kg in 2006 and using the "farm-gate" system of valuing subsistence production in the Pacific islands (Bain 1996)—which discounts the average fish price in the market by 30% as an allowance for getting the product to market—this coastal subsistence production of 30,000 t was worth K105 million.

Locally Based Offshore Catches

Estimates of the catches of the four main commercial species of tuna in the WCPFC area were made by the FFA (FFA 2008), using data sourced from the Oceanic Fisheries Programme of the SPC. The prices were all "delivered" prices in that they reflected the price received at entry to the country in which they were usually sold whether for processing or consumption. Also, bycatch, which is an important component of locally based offshore longline fisheries, was not included.

For longline-caught yellowfin and bigeye tuna, FFA (2008) assumed that 80% of the catch was of export quality and 20% was of nonexport quality. To estimate total value, Japanese fresh yellowfin and bigeye import prices from Oceania were used for export quality tuna, and a value of $1.50/kg was assumed for nonexport grade tuna. Table 10.1 gives local dockside catches and values for tuna fleets based in PNG, based on the FFA (2008) estimate adjusted for bycatch as noted in the table.

Foreign-Based Offshore Catches

The tuna catches in PNG waters by foreign fishing vessels consist entirely of fish caught by purse seiners (Kumoru 2008). These are shown for recent years in Table 10.2, adjusted for bycatch and transshipment costs as noted in the table.

Table 10.1: Tuna Catches by the Papua New Guinea-Based Tuna Fleet

	Gear		2001	2002	2003	2004	2005	2006	2007
Catch (t)[a]	Purse Seine		95,202	128,600	164,168	207,809	230,681	218,664	251,638
	Longline		2,830	2,857	3,895	5,939	4,354	4,135	4,759
	Total		**98,032**	**131,457**	**168,063**	**213,748**	**235,035**	**222,799**	**256,397**
Value ($)[b]	Purse seine		75,291,905	100,222,963	122,810,818	180,287,514	212,089,155	213,083,697	332,266,645
	Longline		10,436,125	10,198,339	12,668,605	18,256,525	11,514,005	13,257,921	13,363,607
	Total		85,728,031	110,421,302	135,479,423	198,544,039	223,603,159	226,341,619	345,630,252
	Total (K)		**288,064,619**	**429,153,914**	**481,105,906**	**640,258,106**	**693,558,186**	**691,753,113**	**1,024,089,635**

K = kina, t = ton.

[a] The catch has been increased for bycatch: 30% for longline and 5% for purse seine.

[b] Catch value has been adjusted: (i) for longline—reduced by 25% to obtain dockside tuna values (rather than destination market values), and increased by 10% to account for the sale of bycatch; and (ii) for purse seine, it is assumed that almost no catch is transshipped and, therefore, the Forum Fisheries Agency (FFA) figures are not adjusted for transport costs.

Sources: FFA (2008) and consultant's estimate.

Table 10.2: Estimating Tuna Catches in Papua New Guinea Waters by Foreign-Based Fleets[a]

	2001	2002	2003	2004	2005	2006	2007
Tuna catch							
Total catch by all fleets in PNG waters (t)	160,285	170,836	396,882	337,126	307,448	432,764	491,774
Catch by PNG fleet (t)	60,304	76,877	133,609	128,950	131,921	167,565	179,897
Catch by foreign fleet (t)	99,981	93,958	263,273	208,175	175,528	265,199	311,877
Catch by foreign fleet adjusted for bycatch (t)	104,980	98,656	276,436	218,584	184,304	278,459	327,471
Catch value							
Value of total catch ($)	144,599,888	151,833,948	326,979,894	324,916,000	308,604,485	448,502,411	715,698,397
Value of PNG catch ($)	61,075,673	74,665,336	118,815,884	135,203,807	141,727,188	182,494,169	261,609,476
Value of foreign fleet catch ($)	83,524,215	77,168,612	208,164,010	189,712,193	166,877,298	266,008,242	454,088,920
Value of foreign fleet catch adjusted for transshipment ($)	70,995,583	65,593,321	176,939,409	161,255,364	141,845,703	226,107,005	385,975,582
Value of foreign fleet catch adjusted for transshipment (K)	238,560,427	254,929,345	628,335,969	520,010,850	439,968,061	691,036,080	1,143,631,355

K = kina, PNG = Papua New Guinea, t = ton.

[a] In the table, the values given by Forum Fisheries Agency (FFA) (destination market prices) were reduced by 15% for transshipment costs to the destination markets. The quantities were increased by 5% to account for bycatch.

Sources: FFA (2008) and consultant's estimates.

Freshwater Catches

Commercial freshwater fisheries in PNG are limited. South-flowing rivers support a small barramundi (*Lates calcarifer*) fishery, although this has recently declined; and there have been seasonal freshwater prawn harvests totaling no more than 10 t/year (Coates 1996).

More than 87% of the population of PNG lives inland without direct access to marine resources. Nevertheless, even in highland areas, where (freshwater) fish stocks are very poor, over 50% of the population engages in fishing activities, traditionally for eels but more recently including exotic species (Coates 1996)—for example, most of the fish sold in the Madang town market are tilapia from the Ramu River system (M. Brownjohn, personal communication, November 2008).

As for the coastal subsistence catches above, a crude estimate of freshwater production was made by updating the mid-1990s freshwater estimate of 13,500 t (Preston 1996a) by 30% for population increase and for the effects of stocking. Assuming an average fish price in inland markets of K4/kg in 2006, the "farm-gate" price would have been K2.80/kg. On this basis, freshwater production in PNG in the mid-2000s is estimated to be 17,500 t worth K49 million.

Aquaculture Harvests

Discussion with the staff of the Aquaculture and Inland Fisheries Section of the NFA and knowledgeable individuals enabled a compilation of information on recent aquaculture production in PNG (Table 10.3). From the table, aquaculture production of PNG in the mid-2000s is estimated to be 200 t worth K2 million.

Table 10.3: Recent Annual Aquaculture Production, Papua New Guinea

Commodity	Production Type	Current Estimated Annual Production	Farm-Gate Price (K/kg)	Annual Production Value (K)	Comment
Tilapia	Subsistence and small-scale commercial	30–40 t	7–10	297,500	Production appears to have fallen remarkably in recent years.
Carp	Subsistence	20–30 t	7–10	212,500	Production appears to have fallen remarkably in recent years.

continued on next page

Table 10.3: continuation

Commodity	Production Type	Current Estimated Annual Production	Farm-Gate Price (K/kg)	Annual Production Value (K)	Comment
Trout	Production for restaurants and supermarkets	5–10 t	25	187,500	Started production in late 2007.
Prawns	Production for restaurants and supermarkets	5	35	175,000	
Pearls	Export				Farm started production in 2007; harvests to date likely have been quite small.
Barramundi		0			Currently no production
Crocodiles	Large and small operations for export	10,000 skins	100	1,000,000	A few large and many small farms. Source of information: D. Wilken, Manager, Mainland Holdings Crocodile Farm.

K = kina, kg = kilogram, t = ton.

Sources: M. Brownjohn, H. Walton, J. Wani, and D. Wilken (personal communication, September 2008).

Summary of Harvests

From the above, a crude approximation of annual production and value in 2007 was made (Table 10.4). The extremely weak factual basis for the estimates of coastal commercial, coastal subsistence, and freshwater catches is acknowledged.

The estimated total value of PNG fisheries to the producer in 2007, in excess of K2.4 billion, is considerably larger than that estimated in the 2008–2012 NFA Corporate Plan and other NFA documents of K350 million–K400 million (NFA 2004; NFA 2008).

The relative contributions of the various fisheries categories by quantity and value are given in Figures 10.1 and 10.2. Note that the values of local and foreign-based offshore fishing are nearly identical.

Table 10.4: Annual Fisheries and Aquaculture Harvest, Papua New Guinea, 2007[a]

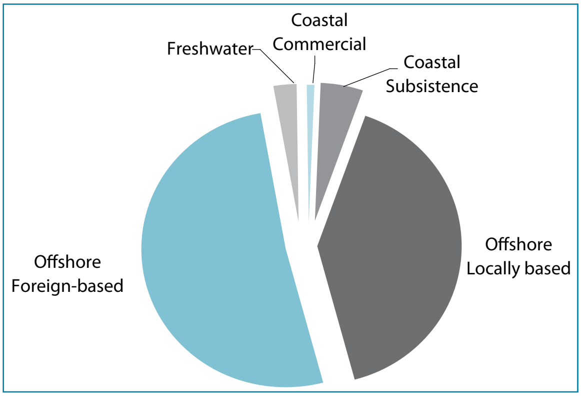
Harvest Sector	Quantity (t)	Value (K)
Coastal commercial	5,700	80,000,000
Coastal subsistence	30,000	105,000,000
Offshore locally based	256,397	1,024,089,635
Offshore foreign-based	327,471	1,143,631,355
Freshwater	17,500	49,000,000
Aquaculture	200	2,000,000
Total	**637,268**	**2,403,720,990**

K = kina, t = ton.

[a] The values in the table are dockside and/or farm-gate prices, except in the case of offshore foreign-based fishing where the value in local waters (overseas market prices less imputed transshipment costs) is given.

Sources: Figure 10.1–10.3 and consultant's estimates.

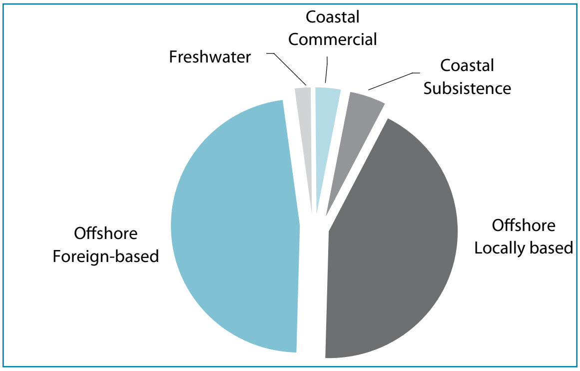
Figures 10.1: PNG Fisheries Production by Fishery Category



PNG = Papua New Guinea.

Source: Table 10.4.

Figures 10.2: Value of PNG Fisheries Production by Fishery Category



PNG = Papua New Guinea.

Source: Table 10.4.

Contribution of Fishing to GDP

Current Official Contribution

Staff of the National Statistics Office (NSO) provided information on gross domestic product (GDP) calculations (K. Geberi, personal communication, September 2008). Several years ago, the NSO experienced difficulties in producing GDP estimates. In early 2000, the responsibility was transferred to the Bank of Papua New Guinea. Methodology differences between the bank and NSO were reconciled recently and the 2006 GDP estimates from NSO are now considered the official estimates. Fisheries contributions since 2000 are given in Table 10.5.

Table 10.5: Official Fishing Contribution to GDP (K million, at current prices)

Item	2000	2001	2002	2003	2004	2005	2006
Fishing, market component	153.0	222.8	204.7	226.4	245.2	292.4	388.4
Fishing, nonmarket component	45.6	49.1	55.5	60.8	63.2	65.8	68.4
Total fishing	198.6	272.0	260.2	287.2	308.4	358.1	456.8
Total GDP	9,735.8	10,996.3	11,872.0	13,241.5	13,459.4	15,094.7	16,896.6
Fishing share of GDP (%)	2.0	2.5	2.2	2.2	2.3	2.4	2.7

GDP = gross domestic product, K = kina.

Source: National Statistics Office, unpublished data.

Method Used to Calculate Official Fishing Contribution to GDP

The general method used by NSO in most economic sectors to calculate GDP contribution is to take the gross output of production and reduce that value by intermediate consumption to determine the value added.[33] The fishing sector is partitioned into market and nonmarket components. For the market subsector, the results of business surveys done in 1991, 1998, and 2004

33 More detailed information on GDP methodology was not available during the consultant's visit to Port Moresby.

were used and extrapolated for future years on the basis of export data. For the nonmarket sector, a 1996 study (Allen et al. 1996) provided the basic information, along with the results of the most recent HIES.

Only limited comment can be made on the above methodology. Fishing carried out by businesses that are too small to be covered by business surveys mentioned above can be omitted in the coverage of "market fishing."

Alternative Estimate of Fishing Contribution to GDP

Table 10.6 below presents an alternative to the official method of estimating fishing contribution to GDP in PNG. It is a simple production approach that takes the values of the six types of fishing and aquaculture activities for which production values were determined and summarized in Table 10.4 above. This approach also determines the value added by using VARs characteristic of the type of fishing concerned. The VARs were determined by knowledge of the fisheries sector and by use of specialized studies (Appendix 3).

It is not intended that the approach in Table 10.6 replace the official methodology, but rather the results obtained can serve as a comparator to gain additional information on the appropriateness and accuracy of the official methodology—and possibly a need for modification.

Table 10.6: Fishing Contribution to GDP Using an Alternative Approach, 2006

Harvest Sector	**Gross Value of Production** (K, from Table 10.4)	**Value-Added Ratio**	**Value Added** (K)
Coastal commercial	80,000,000	0.65	52,000,000
Coastal subsistence	105,000,000	0.90	94,000,000
Offshore locally based			
Longline	40,517,000	0.20	8,103,400
Purse seine	651,233,000	0.50	325,616,500
Freshwater	49,000,000	0.95	46,550,000
Aquaculture	2,000,000	0.65	1,300,000
Total	**927,750,000**		**527,569,900**

GDP = gross domestic product, K = kina.

Sources: Table 10.5 and author's estimates.

The total value added in Table 10.6 (K527.6 million) is about 15% greater than the official value added of K456.8 million. The official contribution from market fishing is close to the combined total of "coastal commercial" and "offshore locally based" in Table 10.4. However, the official contribution from nonmarket fishing is very small compared to the combined total of "coastal subsistence" and "freshwater" in Table 10.6.

Export of Fishery Products

PNG exports a wide variety of fishery products. Marine products exported and marketing channels used by the industry in early 2000 (Diffey 2005) included

- frozen lobster tails and barramundi fillets to Australia (airfreighted on chartered aircraft from Daru via the Torres Islands);
- sashimi grade tuna (chilled airfreight) to Japan, US, Australia, and Southeast Asia;
- canned tuna to Europe, Philippines, and USA;
- canned fish (using imported mackerel) to the Solomon Islands;
- fresh (chilled) fish to the US;
- frozen snapper fillets, mud crabs, lobster tails, and Spanish mackerel by sea freight to Australia;
- frozen tuna loins to Europe (this trade has terminated);
- live food fish, crabs, and lobsters to Australia and Southeast Asia;
- processed and unprocessed bivalve shellfish and their meat, primarily to Southeast Asia and Australia; and
- fishmeal to Southeast Asia.

Exports, including "marine exports," tracked by the Bank of Papua New Guinea are shown in Table 10.7.

Exports of fishery products are shown in Table 10.8 and details of recent tuna exports are shown in Table 10.9.

Table 10.9: Exports of Tuna Products, Papua New Guinea

	Chilled Tuna		Frozen Tuna		Canned Tuna		Loins Tuna		Fishmeal		Shark meat		Shark fins		Total
	Quantity (t)	Value ($ million)	Quantity (t)	Value ($ million)	Quantity (t)	Value ($ million)	Quantity (t)	Value ($ million)	Quantity (t)	Value ($ million)	Quantity (t)	Value ($ million)	Quantity (t)	Value ($ million)	$
2003	2,092	9.3	31,294	16.5	13,753	28	0	0	1,791	0.7	1,312	0.5	86	0.5	56
2004	2,309	13.1	15,754	10.6	16,052	37.3	1,749	1	3,174	1.5	1,317	0.5	135	0.7	65
2005	954	3.9	31,551	27.4	15,495	40.9	14,657	8.3	3,944	1.5	1,418	0.5	179	0.8	83
2006	1,596	7.2	22,430	21.0	16,380	42.3	11,499	8.9	6,110	3.0	1,868	0.7	143	0.8	84
2007	0.844	3.9	20,266	27.1	14,574	40.7	11,436	12.3	5,347	2.7	1,593	0.7	112	0.7	88

t = ton.

Source: Kumoru (2008).

Table 10.7: Total Exports and Marine Exports, Papua New Guinea

Item	2003	2004	2005	2006	2007
Marine exports (t'000)	17.8	43.0	54.5	45.5	49.3
Marine exports value (K million)	125.3	262.1	115.6	154.8	37.7
Marine exports value ($ million)	35.3	81.4	37.3	50.6	12.7
Total value all PNG exports (K million)	1,631.9	1,652.2	2,283.1	2,988.5	2,983.6
Marine exports share of all exports (%)	7.7	15.9	5.1	5.2	1.3

K = kina, PNG = Papua New Guinea, t = ton.

Source: Quarterly Economic Bulletin, Bank of Papua New Guinea. www.bankpng.gov.pg (accessed December 2008).

Table 10.8: Seafood Exports, Papua New Guinea

Item	2003	2004	2005
Seafood exports (t'000)	53.3	52.2	46.3
Value of seafood exports ($ million)	70.0	67.9	53.3
Value of seafood exports (K million)	273.8	231.5	145.9

K = kina, t = ton.

Source: National Fisheries Authority (2006).

The three tables above have conflicting total fishery export values. Table 10.10 compares the data for 2005. To further confuse the issue, PNG fishery export value reported to FAO in 2005 was $113 million, including $97 million for tuna products (FAO 2008). Possible reasons for the discrepancies include differences in accounting for reexports (tuna and mackerel imported for canning and later exported) and differing effectiveness in monitoring large volumes of export documentation.

Table 10.10: Estimates of Fishery Product Exports, Papua New Guinea, 2005

Estimate Source	Product	Value ($ million)
Bank of Papua New Guinea (2008)	Marine exports	37.3
National Fisheries Authority (2005)	Seafood exports	53.3
Kumoru (2008)	Tuna exports	83.0

Source: Estimate source.

A crude estimate of the value of fishery exports in 2007 was obtained by adding the value of tuna products ($88 million [Kumoru 2008]) to the value of other fish, lobsters, shellfish, and shrimp (about $13 million [NFA 2008]) for a total export value of $101 million (K299 million), or about 10% of all exports from the country.

Government Revenue from Fisheries

Access Fees for Foreign Fishing

Negotiated access to PNG's productive waters has long been the primary source of tuna-related revenue for the government. With better organized and more transparent procedures for access agreements in place since 1999, annual access revenue has steadily increased to around K30–K40 million in recent years, involving bilateral arrangements with the People's Republic of China; Republic of Korea; Taipei,China; several Philippine companies, US multilateral treaty, FSM Arrangement, and concessionary arrangements for locally based foreign vessels. In 2003, with record tuna catches in the PNG fishing zone of about 370,000 t, access revenue exceeded $15 million (K50 million) for the first time (Lewis 2004). Access revenue in recent years is shown in Table 10.11.

As fees are normally paid in foreign currency, much of the annual fluctuation is due to currency exchange rates (T. Ward, personal communication, August 2008).

The "revised total revenue and grants" of the Government of PNG in 2007 was estimated to be K7,200 million (PWC 2007). The K44.3 million

Table 10.11: Access Fees for Foreign Fishing in the Papua New Guinea Fishing Zone

Item	2004	2005	2006	2007
Access fees received by NFA (K million)	36.9	35.3	40.3	44.3
Source	NFA (2006)	NFA (2006)	NFA unpublished data	NFA unpublished data

K = kina, NFA = National Fisheries Authority.

Note: Fees stated are exclusive of value-added tax (VAT).

Table 10.12: Other Government Revenue Received by the National Fisheries Authority

Item	2004	2005	2006	2007
Domestic license fees (K million)	1.8	1.9	2.2	1.4
Other fees (K million)	9.4	8.0	(not available)	(not available)
Source	NFA (2006)	NFA (2006)	NFA unpublished data	NFA unpublished data

K = kina, NFA = National Fisheries Authority.

Note: Fees stated are exclusive of value-added tax (VAT).

in access fees received[34] represented about 0.6% of total revenue and grants for the year.

Other Government Revenue from Fisheries

Apart from foreign access fees, the government through NFA receives other fishery revenue (Table 10.12).

Employment

Participation in subsistence fisheries is provided in three reports, summarized below. Although the reports use data from the 1990s, it is unlikely that the circumstances have changed significantly.

- The coastal fishing population (those involved in some fishing activity at least once a week) is about 120,000. People involved in freshwater fishing (those who do some fishing at least once a week) number less than 125,000 (UNDP 1994).
- "Despite the widespread nature of subsistence fishing, in many instances it is sporadic, as most food production continues to be derived from agriculture. Nevertheless, a large number of people, estimated at somewhere between 250,000 and 500,000, participate

[34] According to the Secretariat of the Pacific Community, the National Fisheries Authority has not been receiving revenue from the US tuna treaty for the last two years due to nonratification of an amendment to the treaty. Although the money is in a holding account, strictly speaking, it has not yet been received by PNG (M. Batty, personal communication, April 2009).

in the coastal subsistence fishery. The 1990 census estimated that 130,963 households, which is 23% of all rural households in the country, were engaged in catching fish (both marine and fresh water fishing). Of these households, 60% said they caught fish for home consumption only, while 40% caught fish both for food and for sale. A significant proportion of households were involved in fishing in all provinces except those in the highlands. The highest proportion of fishing households occurred in Milne Bay (14.3% of households), East Sepik (11.3%), and Madang (10.0%)" (Preston 2001b).

- On gender aspects of subsistence fisheries: "Women's role in fishing is much larger than is generally acknowledged. According to the Women's Sector Review, studies have shown that women catch at least 25% of the subsistence catch, or more if the crab catch is added. Furthermore, they are dominant in the processing stage of small-scale fisheries and contribute to the marketing of fish where the husband is involved in catching" (Avalos 1995).

For employment in commercial fisheries, it is important to place the number of jobs in perspective. Results of the 2000 census showed the total number of people employed in the country in 2000 at 2,344,734, of which 1,141,501 (48.7%) were females (NSO 2003). Of the total jobs, 584,682 (25%) were considered "monetary" and 1,760,052 (75%) "non-monetary." Using the Bank of Papua New Guinea index of employment,[35] it is estimated that there were about 774,000 people with monetary jobs in 2008.

The number of people employed in small-scale commercial fishing in PNG has never been adequately surveyed. Many of the current estimates are at least partially based on a UNDP fisheries sector study in late 1980s. Diffey (2005), using several sources, summarized the state of knowledge: "In 1989 UNDP estimated that PNG had about 2,000 coastal village communities with a population of about 500,000 people. Of these it was estimated that 120,000 were involved in regular fishing activity at least once a week and that there were between 2,000 and 4,000 part-time artisanal fishers. These data are confirmed by the 1990 population census where NSO estimated that, of 131,000 coastal rural households, 23% (30,000) were engaged in catching fish with 60% fishing purely for subsistence consumption and 40% for both food and for sale."

Quantifying the number of people engaged in aquaculture in PNG remains elusive. There is a general consensus that many people in the country

[35] Bank of Papua New Guinea: www.bankpng.gov.pg

are involved in small-scale culture of fish, but the various studies give different results. An unpublished report of an Australian Centre for International Agricultural Research (ACIAR) study in 2003 showed 10,000 fish farmers to be involved in inland and highland fish farming (Ponia 2003). SPC (2008b) mentioned an "estimated 10 to 15,000 fish farmers in Papua New Guinea." An ACIAR study on the status of freshwater fish farming in PNG during 2001–2006 (Smith 2007) estimated the number of farms in 2001 in the 19 provinces of PNG to be 5,418. On the degree of involvement of people in these farms, "approximately 5,000 families in the highlands who each had one or two fish ponds that grew 50 fish to 500 g" (Smith [2007], quoting Mufuape [2000]).

The tuna industry provides many of the formal fishing jobs in the country. Employment in the tuna industry greatly increased during 2002–2008 (Table 10.13). Considering the "monetary employment" of 774,000 in PNG in 2008, the 8,990 tuna jobs represented about 1.2% of all monetary jobs that year.

Table 10.13: Locals Employed in the Papua New Guinea Tuna Industry

Item	2002	2006	2008
Local jobs on vessels	460	110	440
Local jobs in shore facilities	2,707	4,000	8,550
Total	**3,167**	**4,110**	**8,990**

Source: Gillett (2008).

A recent study on gender in the tuna industry (Sullivan and Ram-Bidesi 2008) indicated that about 7,000 women worked in the PNG tuna industry, including onshore handling and loining or canning, and technical and administrative positions. The study concluded that the tuna industry employs 3.3% of all formally employed women.

Fish Consumption

Recent information on fish[36] consumption in PNG is summarized below (Preston 2001b).

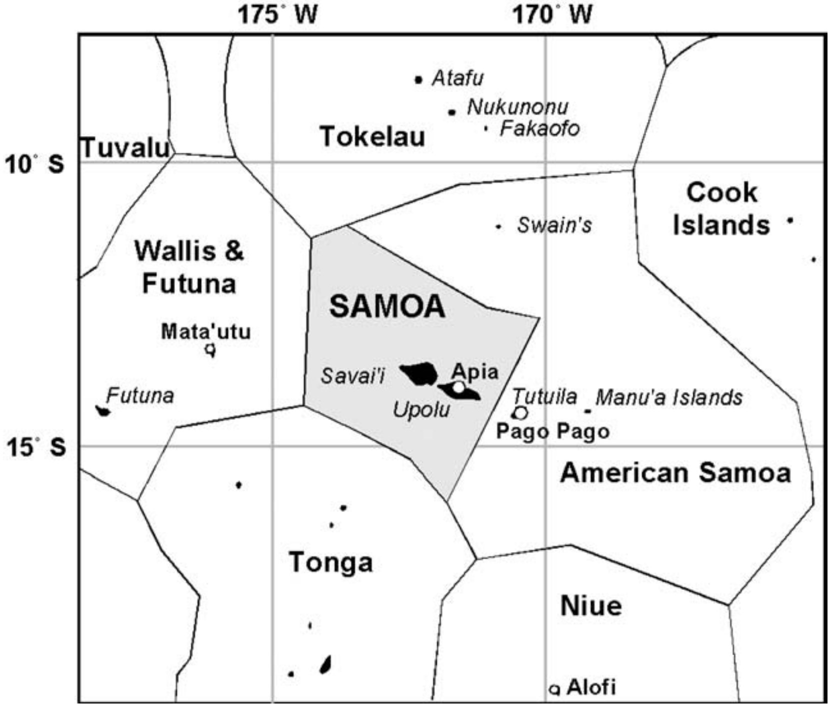
36 Preston (2001) used the term "fish" to describe freshwater and marine finfish, shellfish, and other aquatic food products.

- Most documents and reports on nutrition in PNG focus on agriculture and animal husbandry and pay little attention to fish. Nevertheless, fish play an important role in food security. On average, Papua New Guineans were estimated (Gibson 2000) to have consumed 10 kg of fresh, frozen or dried fish per capita, with a total value of K60 million, in 1996. Urban dwellers had higher per capita consumption rates than rural dwellers (21 kg as opposed to 8 kg) but consumed less total value of fish (K26 million versus K34 million) due to their smaller numbers.
- In addition to fresh fish and seafood, tinned fish is an important source of dietary protein for many people. On average, Papua New Guineans consumed 3 kg per capita of tinned fish valued at K63 million in 1996. Again, urban dwellers had a higher per capita consumption than rural people (7 kg as against 2 kg), but consumed a lower total value (Gibson 2000).
- Most fish and seafood consumed in PNG is domestically produced, including tinned fish. Accounting for seafood imports and exports, the apparent per capita seafood consumption[37] was estimated at 18.2–24.9 kg/year (Preston 2000).
- Together fresh and tinned fish provide a small but important source of high-quality protein in the Papua New Guinean diet. Fresh fish provides about 1.1% of average calorific intake to the average Papua New Guinean (0.9% in rural areas and 2.3% in urban areas), while tinned fish provides an average of 0.6% (0.5% in rural areas, 1.4% in urban areas) (Gibson 2000).

On a national basis, per capita fish consumption in 2002–2003 (whole weight equivalent) was 28.1 kg per capita per year in urban areas (fresh fish made up 76% of this amount) and 10.2 kg per capita per year in rural areas (77% fresh fish) (Bell et al. 2009), based on information in Gibson (2000).

[37] Apparent consumption is the composite of domestic production (subsistence and commercial) plus imports, less exports.

Samoa



Source: Secretariat of the Pacific Community.

Fish Production

Coastal Commercial Catches

The widespread use of "alia" catamaran fishing craft is unique to Samoa. Categorizing their fishing activity requires some special attention. While it is recognized that those vessels are not industrial scale, due to the type of gear used and the difficulty and logic of separating the catch of those vessels from larger catamaran and monohull vessels, the catch from alia longliners in this report is considered to be a component of the "offshore locally based" catch.

Samoa has devoted more attention to estimating the production from its small-scale fisheries than any other Pacific island country. A brief summary of these efforts follows (Mulipola et al. 2007).

- The first assessment of Samoa's fisheries was completed by the Department of Statistics in 1978. About 48 villages on both Upolu and Savaii were surveyed for one week each quarter over the course of the year to determine total landings and seafood consumption. Offshore landings for the year were estimated at 424 t, while inshore landings were estimated at 666 t.
- In 1991, the Fisheries Division and FAO conducted the Inshore Resource Assessment Project. Originally intended to be nationwide, the study focused on Upolu due to damage sustained on Savaii during cyclones in 1990 and 1991. It was estimated that total inshore fisheries production in Samoa was 4,800 t/year.
- In a 1997 study of the subsistence and artisanal fisheries of Savaii, additional analysis of data from the 1991 study was also included. The study estimated total inshore production in all of Samoa to be 4,200 t/year.
- A nationwide household fisheries survey was undertaken in October and November 2000. The total coastal catch for 2000 was estimated at 7,169 t worth ST45 million. A total of 2,876 t was sold or given away, leaving 4,293 t for home consumption.

Coastal commercial production in 2000 was estimated at 3,086 t worth ST19.9 million (Gillett and Lightfoot 2001).

Data from the 2002 HIES were analyzed in the present study to estimate the coastal commercial catch in 2002 at 4,076 t worth ST30 million, and the coastal subsistence catch at 4,437 t worth ST22.8 million.

In 2003, there were 11,700 fishers in Samoa with total landings of 12,270 t, according to the results of two one-week creel surveys in 112 villages nationwide (Mulipola 2003).

The most recent estimate of coastal fisheries production was 13,686 t worth ST84 million, based on a survey of 939 households on fish consumption and related matters, validated through a creel census (Mulipola et al. 2007).

After correcting for fish price changes between 2000 and 2002, the 2000 HIES can be compared to the 2000 fisheries survey of fish production. For the coastal commercial component, the HIES gave 50% more value and 32% more catch. For coastal subsistence fisheries, the data sets were very close (3% value difference and 5% catch difference). Discussion with the HIES specialist at SPC (C. Ryan, personal communication, November 2008) indicated that the major difference between the two studies was the method of obtaining information from respondents. The HIES used individual diaries filled out by respondents over a two-week period (the HIES staff were able to stay in the selected villages during the entire two-week diary-keeping period), while the 2000 fisheries survey used general recall (e.g., "What is the usual amount of seafood caught by people in your household in one week?").

For the present study, the HIES catch estimates were increased to account for population increase during 2002–2007 and the 2007 market and roadside fish price of ST12.41/kg was used (Fisheries Division 2008d). On this basis, the 2007 production from Samoa's coastal commercial fisheries is estimated to be 4,129 t worth ST51,240,890.

Coastal Subsistence Catches

Coastal subsistence production in 2000 was estimated at 4,293 t worth ST21.6 million (Gillett and Lightfoot 2001). The 2000 fisheries survey and the 2002 HIES gave similar results on subsistence fisheries production. Updating the HIES information as above, it is estimated that production from coastal subsistence fisheries in Samoa in 2007 was 4,495 t. Assuming a price 70% of the above 2007 commercial fish price, the value of this catch was ST39,048,065.

Locally Based Offshore Catches

The numbers of boats in the locally based offshore fleet in recent years, all longliners, are given in Table 11.1.

Estimates of the catches of the four main commercial species of tuna in the WCPFC area were made by the FFA (FFA 2008), using data sourced from the Oceanic Fisheries Programme of the SPC. The prices used were all "delivered" prices in that they reflected the price received at entry to the country

Table 11.1: Offshore Fishing Fleet, Samoa

Class	Vessel Length	Number of Vessels 2006	Number of Vessels 2007
Class A	≤11 m	37	43
Class B	>11 m ≤12.5 m	2	2
Class C	>12.5 m ≤15 m	2	2
Class D	>15 m ≤20.5 m	2	13
Class E	>15 m	13	13
Total		**54**	**60**

m = meter.

Source: Fisheries Division (2008d).

in which they were usually sold whether for processing or consumption. Also, bycatch, which is an important component of locally based offshore longline fisheries, was not included.

For longline yellowfin and bigeye tuna, FFA (2008) assumed that 80% of the catch was of export quality and 20% was of nonexport quality. For export quality, Japanese fresh yellowfin and bigeye tuna import prices from Oceania were used, while the price of nonexport grade tuna was assumed to be $1.50/kg. The catch composition during FY2008 was 82.6% albacore, 1.5% bigeye tuna, 10.7% yellowfin tuna, and 5.2% bycatch (Fisheries Division 2008d).

Table 11.2 gives catches and local dockside values for the tuna fleets based in Samoa, adjusted for bycatch and value as noted in the table.

Foreign-Based Offshore Catches

There is only a very small catch by foreign fishing vessels—an average of 13 t/year, all from longliners for 2003–2007 (FFA 2008). There was also a small catch by US purse seiners—9 t in FY2005 and 27 t in FY2006—but none in FY2004, according to unpublished NMFS public domain data. For 2003–2007, it is assumed here that the purse seine catch in the waters of Samoa was 12 t/year.

With regard to annual catch value during 2003–2007, it is assumed that 13 t of foreign longline catch was worth $32,500 and the 12 t of purse seine catch was worth $16,800. The annual foreign catch in the period was, therefore, 25 t worth $49,300 (ST129,166 in 2007).

Table 11.2: Tuna Catches by the Samoa-Based Tuna Fleet[a]

Item	2003	2004	2005	2006	2007
Tuna catch (t)[a]	2,663	1,820	1,542	2,503	3,519
Bycatch (t)[b]	253	162	139	210	236
Total catch (t)	2,916	1,982	1,681	2,713	3,755
Catch value ($)[a]	6,782,964	6,311,711	4,880,538	8,311,447	8,818,637
Adjusted catch value ($)	6,443,816	5,996,125	4,636,511	7,895,875	8,377,705
Adjusted catch value (ST)	19,313,563	16,666,320	12,565,343	21,940,603	21,910,631

ST = tala, t = ton.

[a] In the table, the amount of bycatch is the figure given in Fisheries Division (2008d). The catch value is (i) reduced by 15% to obtain dockside tuna values and to allow for reduced exports of fresh tuna relative to other Pacific island countries, and (ii) increased by 10% to account for sales of bycatch.

Sources: [a] Forum Fisheries Agency (2008), [b] Fisheries Division (2008d), and consultant's estimate.

Freshwater Catches

In Samoa, 2% of all households do at least some fishing on inland rivers and lakes (ADB 2008c). The main freshwater fishery species are tilapia (there are occasionally roadside sales near lakes), eels, and freshwater shrimp. The total annual harvest is unknown, but likely to be about 10 t/year (A. Mulipola, Assistant Chief Executive Officer of the Ministry of Agriculture and Fisheries, personal communication, September 2008). This 10 t annual harvest was valued, using the approach above, for coastal subsistence catches, at ST87,000.

Aquaculture

Aquaculture in Samoa at present is at village level, mainly using tilapia in local waterways and grow out of giant clams. Commercial aquaculture has not developed, despite attempts using a range of species (Rimmer et al. 2001).

Twelve villages were nursing giant clams in their lagoon reserves in FY2008 under the Community-Based Fisheries Management Programme. Declining trends have been noticed in the number of live clams due to natural mortality and poaching (Fisheries Division 2008d). The nurseries are oriented to enhancing the wild giant clam stock.

In FY2008, 5,000 fish fingerlings were produced and distributed to community, group, and individual farmers. A total of six old and five new farms were stocked with tilapia (Fisheries Division 2008d). The tilapia ponds are mostly small with poor productivity. The total annual harvest is likely to be about 10 t (A. Mulipola, personal communication, September 2008). The harvest value is estimated, using the approach for coastal catches, at about ST87,000.

Summary of Harvests

From the above sections, a crude approximation of annual production and value in 2007 was made (Table 11.3). The factual basis for the estimates of coastal commercial and coastal subsistence catches appears stronger in Samoa than in any other Pacific island country. The accuracy of the assessment of the total catch and value of Samoa's 2007 production appears relatively good.

Table 11.3: Fisheries and Aquaculture Harvest in Samoa, 2007[a]

Harvest Sector	Quantity (t)	Value (ST)
Coastal commercial	4,129	51,240,890
Coastal subsistence	4,495	39,048,065
Offshore locally based	3,755	21,910,631
Offshore foreign-based	25	129,166
Freshwater	10	87,000
Aquaculture	10	87,000
Total	**12,424**	**112,502,752**

ST = tala, t = ton.

[a] Values in the table are dockside/farm-gate prices.

Source: Consultant's estimates.

Contribution of Fishing to GDP

Current Official Contribution

The fishing contribution to GDP in recent years is shown in Table 11.4.

Method Used to Calculate Official Fishing Contribution to GDP

As shown in Table 11.4, value added from fishing comprises that from monetary fishing and non-monetary fishing. Monetary fishing categories are inshore landings, crustaceans, offshore tuna plus other purchased and consumed, export tuna for canning, exports by airfreight chilled, and all other exports. For this study, the total value of the above six categories was multiplied by a VAR of 0.85 to obtain the value added for monetary fishing.

Table 11.4: Official Fishing Contribution to Samoa GDP (ST)

Item	2004	2005	2006	2007
Fishing, monetary	20,360,733	16,699,109	17,822,536	27,810,917
Fishing, non-monetary	40,748,354	42,915,756	46,074,083	46,729,629
Fishing, total	61,109,087	59,614,865	63,896,619	74,540,546
Total Samoa GDP	1,049,408,000	1,151,251,000	1,249,841,000	1,372,394,000
Fishing share of Samoa GDP (%)	5.8	5.2	5.1	5.4

GDP = gross domestic product, ST = tala.

Source: Bureau of Statistics, unpublished data (A. Salani, personal communication, September 2008).

For subsistence fishing, the value of subsistence catch was multiplied by a VAR of 0.95, using the year 2000 as a benchmark. The price for a particular year was the 2000 price, modified by the consumer price index (CPI). The quantity assumed was the 2000 quantity, modified by a factor that is inversely proportional to the longline landings, assuming that the more longline landings, the less demand for subsistence catch.

MOF (2008) stated that "recent GDP estimates for Agriculture and Fishing have been revised to incorporate the1999 Agriculture Census and the 2000 Fishing Survey."

The major comments that can be made on this methodology are:

- The price used for subsistence fish (e.g., ST4.74 in December 2007) appears quite low. Average 2007 market and roadside fish prices[38] were estimated at ST12.41/kg (Fisheries Division 2008d). Using the "farm-gate" system of valuing subsistence production—which discounts the average fish price in the market by 30% as an allowance for getting the product to market—gives a subsistence price of ST8.69/kg.
- The VARs in the official method for monetary fishing appear quite high. Appendix 3 examines the economics of various types of fishing in the Pacific islands and concludes, for example, that a VAR of 0.47 should be used for alia tuna longlining, 0.20 for locally based conventional tuna longlining, and 0.60–0.80 for fishing in a small outboard powered boat.

Alternative Estimate of Fishing Contribution to GDP

Table 11.5 presents an alternative to the official method of estimating fishing contribution to GDP in Samoa. It is a simple production approach that takes the values of five types of fishing/aquaculture activities for which production values were determined and summarized in Table 11.3 above. This approach also determines the value added by using VARs characteristic of the type of fishing concerned. The VARs were determined by knowledge of the fisheries sector and by use of specialized studies (Appendix 3).

It is not intended that the approach in Table 11.5 replace the official methodology, but rather the results obtained can serve as a comparator to gain

38 The outlets examined in Fisheries Division (2008, page 2) were the Apia fish market, Fugalei agro-produce market, Apia–Faleolo roadsides, and the Salelologa market. The total of about 145 t of inshore fishery products was worth ST1.8 million, or ST12.41/kg.

Table 11.5: Fishing Contribution to GDP Using an Alternative Approach, 2007

Harvest Sector	Gross Value of Production (ST, from Table 11.3)	Value-Added Ratio	Value Added (ST)
Coastal commercial	51,240,890	0.80	40,992,712
Coastal subsistence	39,048,065	0.90	35,143,259
Offshore locally based[a]	21,910,631	0.40	8,764,252
Freshwater	87,000	0.90	78,300
Aquaculture	87,000	0.74	64,380
Total			**85,042,903**

GDP = gross domestic product, ST = tala.

[a] An economic study of local longlining in Samoa determined that the value-added ratio for alia tuna longlining in Samoa was 0.46 and that for conventional tuna longlining was 0.38 (Hamilton 2007).

Sources: Table 11.3 and consultant's estimates.

additional information on the appropriateness and accuracy of the official methodology—and possibly a need for modification.

Total value added from fishing in Table 11.5 (ST85,042,903) is 14% greater than the official estimate of ST74,540,546. In the alternative approach, the subsistence value added is considerably less than the official figure. On the other hand, in the alternative approach, the commercial value added (coastal commercial + offshore locally based) is almost 80% greater than the official estimate of monetary fishing.

Export of Fishery Products

Fish exports are about half of all Samoan exports, as shown in Table 11.6. Additional information is given in Table 11.7.

Table 11.6: Fish and Total Exports, Samoa

Item	2002	2003	2004	2005	2006	2007
Fish exports (ST million)	29,034	15,760	13,523	11,583	15,452	20,000
Total value of exports (ST million)	46,283	44,271	33,127	32,488	28,746	36,190
Fish exports share of all exports (%)	62.7	35.6	40.8	35.7	53.8	55.3

ST = tala.

Note: Time periods are calendar years.

Sources: SBS (2008) and MOF (2008).

Table 11.7: Quantity and Value of Fish Exports, Samoa

		2003	2004	2005	2006	2007	2008
Frozen Fish	Quantity (t)	2,259.0	1,345.3	1,477.7	1,042.1	1,819.3	2,567.7
	Value (ST)	16,257,543	9,376,849	10,825,626	7,626,230	13,405,456	18,169,894
Fresh Chilled	Quantity (t)	567.2	430.3	481.0	144.6	429.8	157.9
	Value (ST)	7,480,845	5,457,612	6,246,017	1,775,155	4,008,088	2,215,038
Total	Quantity (t)	2,826.2	1,775.6	1,958.7	1,186.7	2,249.1	2,725.5
	Value (ST)	23,738,388	14,834,461	17,071,643	9,401,385	17,413,544	20,384,932

ST = tala, t = ton.

Source: Fisheries Division (2008d).

Table 11.8: Fishery Products Exported for *Faaoso,* FY2008

Year	Pelagic species (kg)	Inshore species (kg)
July–December 2007	1,131	5,160
January–June 2008	409	4,635
Total	**1,540**	**9,795**

FY = fiscal year, kg = kilogram.

Source: Fisheries Division (2008d).

The Customs Department, Central Bank of Samoa, and Fisheries Division all record the fishery exports of Samoa. Because the information for each of the three agencies comes from the same documents, the amounts recorded by each agency should be identical. In practice, they are all slightly different, probably because of the difficulties associated with compiling summaries from a large number of export documents.

Further, information on fishery exports reported to FAO (FAO 2008) contains items that are not produced in Samoa, such as "Salmonoids, frozen" and "Herrings prepared or preserved."

Since 1997, export bans on several types of fishery products (coral, aquarium fish, and bêche de mer) have resulted in almost all commercial fishery exports in recent years being tuna products, according to Fisheries Division staff (A. Mulipola, personal communication, September 2008).

Finally, a significant amount of noncommercial fishery exports occur, as gifts for family and friends living overseas (*faaoso*) (Table 11.8).

Government Revenue from Fisheries

Access Fees for Foreign Fishing

With the exception of purse seiners from the US that are covered by the multilateral tuna treaty (to which Samoa is a party), no foreign-based vessels have been authorized to fish in Samoan waters since the 1990s (U. Fa'asili Jr., personal communication, September 2008).

Under the terms of the US multilateral tuna treaty, Samoa and other Pacific island countries receive payments from the Government of the United States and the US tuna industry that are associated with fishing access by US purse seiners. Table 11.9 gives the funds received by Samoa from the treaty for recent years.

Table 11.9: Payments to Samoa from the US Multilateral Treaty ($)

Licensing Period	15% Shares[a]	85% Shares[b]	PDF Shares[c]
16th Period, 15 June 2003–14 June 2004	147,357.28	0	111,125.00
17th Period, 15 June 2004–14 June 2005	147,310.43	2,380.84	111,125.00
18th Period, 15 June 2005–14 June 2006	147,209.70	7,399.46	111,125.00
19th Period, 15 June 2006–14 June 2007	(145,860.78)	no information	(111,125.00)
20th Period, 15 June 2007–14 June 2008	(145,860.78)	no information	(111,125.00)

US = United States.

[a] The "15% shares" ($2,042,050.92 in 2008) are shared equally between all countries that are parties to the treaty.

[b] The "85% shares" ($14,273,117.87 in 2008) are apportioned to countries based on where the catch by US vessels was made. These amounts in the table are zero because US seiners have not attempted to fish in Samoa in over 20 years.

[c] The "PDF shares" ($1,555,750.00 in 2008) are shared equally between all countries that are parties to the treaty for project development work.

Source: Unpublished United States National Marine Fisheries Service public domain data.

Payments during the 19th and 20th periods require extra explanation. For political reasons, since mid-2006, the Government of the United States has not been able to formally transfer funds of this type directly to the Government of Samoa. An equivalent amount is, however, transferred to Samoa from treaty funds deposited with the administrator of the US treaty, which is the FFA.

Some Pacific island countries consider that all payments under the US treaty are for fishing access, while others treat some components (e.g., the PDF shares) as aid. The total revenue and grants collected by the Government of Samoa in FY2008 was ST441.10 million (MOF 2008). If all the money received by Samoa from the US treaty is considered as payment for access, fishing access fees amount to about 0.15% of all government revenue and grants.

Other Government Revenue from Fisheries

License fees collected from local fishing vessels during FY2008 are shown in Table 11.10. Total revenue collected for "Fisheries Management, Planning, and Research Services" in FY2008 was ST180,300, with a projection for ST194,900 to be collected in FY2009 (Government of Samoa 2008). According to the staff of the Ministry of Finance, these amounts are likely to be all money (vessel license fees [Table11.10] plus other fees) collected by the Fisheries Division (L. Sefo-Leau, personal communication, September 2008).

Table 11.10: Fishing Vessels License Fees in Samoa, FY2008

Class	Number of Fishing Vessels	License Fee	Revenue Generated
A	38	ST200	ST7,600
B	1	ST500	ST500
C	2	ST3,000	ST6,000
D and E	13	ST7,000	ST91,000
Total	**54**		**ST105,000**

FY = fiscal year, ST = tala.

Source: Fisheries Division (2008d).

Employment

Formal registered employment (defined as those people who make national provident fund contributions) data (Table 11.11) show that, overall, fishing provides only 0.9% of the formal registered employment in Samoa, but the growth trend in formal registered employment in fishing is considerably greater than that for all industries. Of those formally employed in fishing, 88.3% are males.

Table 11.11: Formal Registered Employment

Item	2003	2004	2005	2006	2007	Growth Trend[a]
Employed males						
Fishing	63	65	62	148	173	6.8
All industries	11,942	12,161	12,819	12,964	13,114	0.5
Employed females						
Fishing	12	12	14	15	23	4.1
All industries	8,737	8,618	8,789	8,837	9,086	0.3
Employed persons						
Fishing	75	77	76	163	196	6.4
All industries	20,679	20,779	21,608	21,802	22,150	0.4

[a] The "growth trend" is the log linear quarterly trend in growth.
Source: Samoa Bureau of Statistics, unpublished data.

Table 11.12: Employment in Tuna Fisheries, Samoa

Item	2002	2006	2008
Local jobs on vessels	674	110	255
Local jobs in shore facilities	108	90	40
Total	**782**	**200**	**295**

Source: Gillett (2008).

Interestingly, alia-type tuna longlining generates more jobs per catch than conventional longliners: 16 and 5 employees per 100 t, respectively (Hamilton 2007). Employment in tuna fishing in recent years is shown in Table 11.12.

A survey conducted to assess the socioeconomic status of rural villages with regard to fishing practices (Mulipola et al. 2007) contained the following information on employment in small-scale fishing:

- Although only 7.3% of the population are fishers, 41.7% of households have at least one fisher. When raised to the population of Samoa, there are approximately 12,844 fishers.
- Over 60% of households regularly receive remittances from relatives overseas. Over 50% of households have a member earning income from a wage paying or salaried job. About 23% of households reported an income from fishing.

- In households with fishing incomes, fishing contributed to an average of 41% of the total household income.
- Traditionally, a woman's fishing role is gleaning shellfish or bêche de mer in shallow areas along the shore. However, there seems to have been a sharp decline in the number of female fishers, from 18% in 1991 and 1997 to 13.5% in 2007. Respondents suggested that it is more difficult to find organisms nowadays than in the past.

About 18% of all village fishers are female. They contribute around 23% of the total weight of seafood (Lambeth 2001). Because women collect the majority of marine bivalves and other invertebrates in Samoa, it is estimated that they provide 20% of the seafood consumed.

A fisher creel census undertaken in 2003 (Mulipola 2003) indicated that there were 8,377 fishing households in Samoa (36% of all households), with an average number of fishers of 1.4 per fishing household—a total of 11,700 subsistence and small-scale commercial fishers of whom 9,600 (82%) were male and 2,100 female. Similar proportions were found in the household survey in 2000 (82% male fishers) and an agriculture census in 2002 (86% male fishers).

Of the total, 37% were considered full-time (fishing about 5 days/week) and the remainder part-time. Fishers aged 20–29 years, 30–39 years, and 40–49 years accounted for 18%, 38%, and 29%, respectively, of the total fishers.

The 2002 Samoa HIES gives information on "main daily activity," but the results are not disaggregated down to the fishing level.

Fish Consumption

Table 11.13 summarizes recent estimates of fish consumption in Samoa. It can be seen that there is some inconsistency, or at least lack of clarity, in what is being measured (fresh fish only, fresh plus canned) and how it is measured (fish actually consumed versus whole fish equivalent).

Table 11.13: Estimates of Fisheries Consumption in Samoa, Various Years

Source	Year for Estimate	Fish Consumption Estimate	Comments
Preston (2000)	1995	46.3 kilograms (kg) of fish per capita per year	Based on FAO production, import, and export statistics.
Lambeth (2001)	1990s	Women contribute around 23% of total weight of seafood. Because women collect most of the marine bivalves and other invertebrates in Samoa, it is estimated that they provide 20% of the per capita seafood consumption of 71 kg/year, consisting of 44 kg of fresh fish, 13 kg of invertebrates and seaweed, and 14 kg of canned fish.	Gender-oriented survey applied to earlier consumption data.
Passfield (2001)	2000	Average per capita consumption of (local) seafood is 57.0 kg per annum, made up of 44.0 kg of fish and 13.0 kg of invertebrates and seaweed. In addition, canned fish consumption per capita is 14.0 kg per annum; total (local plus imports) is 71.0 kg per capita per year.	Survey was based on respondents' recall of their fishing activities and seafood consumption patterns. Used whole fish equivalent.
Mulipola et al. (2007)	2006	*Fresh fish* • average frequency of consumption of finfish = 2.8 times/week, invertebrates = 0.8 day/week • average per capita consumption per year = 59.4 kg (163 grams/day) • total consumption per year = 10,508 tons (7,900 tons for Upolu, 2,608 tons for Savaii) *Tinned fish* • average frequency of consumption = 4.5 days/ per week	Based on response of people asked to estimate their usual catch. The study appears to use food actually consumed.

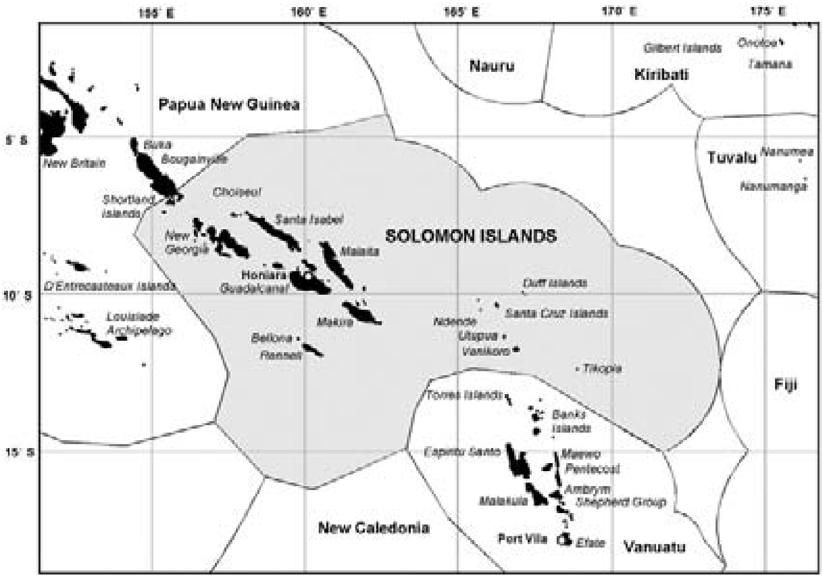
continued on next page

Table 11.13: continuation

Source	Year for Estimate	Fish Consumption Estimate	Comments
		• average per capita consumption = 73 kg/year (206 grams/person/day) • 8,120 tons of tinned fish consumed per year in Samoa (Upolu, 2,608 tons for Savaii)	
Bell et al. (2009)	2002	Average annual per capita fish consumption (whole weight equivalent) is 45.6 kg in urban areas and 98.3 kg in rural areas.	Based on 2002 HIES information.

FAO = Food and Agriculture Organization of the United Nations, HIES = household income and expenditure survey, kg = kilogram.

Solomon Islands



Source: Secretariat of the Pacific Community.

Fish Production

Coastal Commercial Catches

The structure of coastal commercial fisheries in the Solomon Islands was summarized by Green et al. (2006) as follows:

> "The small-scale commercial fisheries are mainly located near the main urban area of Honiara, and to a much lesser extent, around the towns of Auki on Malaita Island and Gizo in the west. These fisheries are oriented to providing primarily finfish to wage-earning residents. The other common form of small-scale commercial fishing is that for nonperishable fishery products for export. The most important of these items are trochus shells, bêche de mer, and shark fins. These commodities are an important source of cash for Solomon Islanders, especially in the isolated villages since the demise of the copra industry."

In addition to the above types of coastal commercial fishing, an inshore fishery exists for baitfish for Soltai pole-and-line tuna vessels.

Coastal commercial fisheries production in the Solomon Islands in early 1990s was estimated at 1,150 t worth $4,343,811 (Dalzell et al. 1996). Production during 1988–2000 was estimated at 3,200 t worth SI$9,200,000 (Gillett and Lightfoot 2001).

For a more recent and accurate assessment of coastal fisheries production, three components need to be considered: sales for domestic consumption, exports, and the Soltai tuna bait fishery.

With respect to production for domestic sales, there seem to be few original new estimates; most recent citations appear to be a recycling of previous estimates, especially that made by Crossland and Philipson (1993). The recent HIES offers little insight because fishery products of coastal origin (as opposed to tuna products) cannot be determined from the category "fish and shellfish" used in the survey. Recent annual reports of the Ministry of Fisheries and Marine Resources do not contain information on the production of coastal fisheries. An analysis of seafood marketing in the Solomon Islands in 2001 (Russell and Buga 2001) does not contain information useful for estimating the production of coastal commercial fisheries, or even the amount of fish sold in Honiara. A fishery statistics paper that year (Anon 2001) contains information on exported coastal fisheries products only.

The available fragmented information on sales for domestic consumption includes a projection for fish demand in Honiara of 1,390 t for 2002 (Crossland and Philipson 1993), an estimated 1,115 t of reef and lagoon fish taken for commercial sale (GPA 2000), and an estimated 245 t of fish coming from rural areas to the Honiara main market (Lindley 2007).

The marketing officer of the Ministry of Fisheries and Marine Resources indicates a buying price of SI$8/kg for most finfish at the rural fisheries centers since 2004 (B. Buga, personal communication, August 2008).

For the tuna bait fishery, the annual catch for 2002 was 828 t (Barclay 2008). The numbers of pole-and-line vessels operating in recent years were: 2002, 12 vessels; 2006, 11 vessels; 2008, 1 vessel (Gillett 2008a). This suggests that baitfish catches for a fleet of 10 vessels are about 800 t worth SI$800,000 (at SI$1/kg).

Exports of non-tuna fisheries products in 2007 were valued at SI$5.2 million, according to the Central Bank of the Solomon Islands (CBSI 2008). The Ministry of Fisheries and Marine Resources (MFMR 2008a) gave a very different value, SI$18.5 million (Table 12.1). Exports were also reported to FAO (Table 12.2). The table lists the six major non-tuna exports, the total of which, in local currency, amounts to about SI$17.5 million in

Table 12.1: Non-Tuna Fishery Exports, according to Ministry of Fisheries and Marine Resources

Year	Export Quantity (t)	Export Value SI$ million
2003	304	0.4
2004	453	1.5
2005	not available	not available
2006	543	7.6
2007	921	18.5

SI$ = Solomon Islands dollar, t = ton.

Source: Ministry of Fisheries and Marine Resources (2008a).

Table 12.2: Major Non-Tuna Fishery Exports as Reported to FAO

Product	2005 ($'000)	2006 ($'000)
Sea cucumber, dried, salted, or in brine	766	33
Shark fins, dried, salted, etc.	70	90
Rock lobsters	69	113
Ornamental fish	229	226
Miscellaneous corals and shells	267	431
Coral and the like	925	876

FAO = Food and Agriculture Organization of the United Nations.

Source: FAO (2008).

2005 and SI$13.5 million in 2006. These values (CBSI, MFMR, FAO) all appear to be free on board (FOB) values.

Trade data for fishery products are collected by the Ministry of Finance and by the Ministry of Fisheries and Marine Resources through its License, Surveillance and Enforcement Division (Infofish 2008).

As shown above, there is a wide range of estimates for production from coastal commercial fisheries in the Solomon Islands. What can be stated with some degree of certainty is that in the previous decade

- demand has been affected by an increase in the urban population (increased demand), and by increased tuna transshipment with its associated supply of reject fish (decreased demand);
- depreciation of the local currency created a greater incentive to harvest; and
- total value of coastal commercial production is greatly affected by the value of the bêche de mer harvest. Historical records for bêche

de mer show that exports were worth SI$4.79 million in 2001, SI$2.02 million in 2002, and SI$2.26 million in 2003 (Lindley 2007). A ban on export of bêche de mer was imposed in 2006 and, according to MFMR (2008a), exports were SI$9,900 in that year, but increased greatly to SI$10,445,248 in 2007 after the ban was rescinded.

A selective use of the above information enables crude estimates of production from the three components of coastal commercial fisheries in recent years, as follows:

- Local sales for domestic consumption: about 1,500 t at about SI$12 million annually to the fishers for 2005–2007.
- Baitfish: about 800 t valued at SI$0.8 million annually to the recipient communities for 2005–2007.
- Exports: about 950 t worth SI$12.5 million annually to the fishers for 2005–2007; about 750 t valued at SI$9.5 million for 2006.

Coastal Subsistence Catches

There has been little, if any, recent original research on subsistence fisheries production in the Solomon Islands. Many of the estimates of coastal subsistence fisheries production in the country can be traced back to one of two statements:

- "Virtually no data have been collected on the artisanal and subsistence fisheries in the past, apart from the irregular reports of fish purchases and sales through the fisheries centers and substations. Current estimates of the artisanal and subsistence production are based on a 1983 estimate of 40.0 kg per capita consumption, giving a national production of 6,000 to 12,000 tonnes" (Cook 1988).
- "A survey conducted by the National Statistics Office in 1983 indicated an average per capita fish consumption of 25.7 kg/year. A subsequent survey in 1988 (unpublished) indicated total seafood consumption of 34.4 kg/person/year, comprising 22.4 kg of marine fish and 12 kg of shellfish. Shellfish consumption appeared to be concentrated in the Western Provinces. Using these figures, the national total subsistence catch is probably of the order of 10,000 tonnes/year in 1990" (Skewes 1990).

Subsistence production in late 1990s was estimated at 8,817 t of finfish and 4,747 t of shellfish, for a combined total of 13,564 t (World Bank 2000; sources and methods not specified), and at 13,000 t worth SI$39 million (Gillett and Lightfoot 2001).

The population of Solomon Islands increased by about 20% between the 2001 estimate and 2007 (SPC 2008a). If the subsistence harvest increased by 15% during the same period, production would have been about 15,000 t in 2006.

Using the "farm-gate" system of valuing subsistence production (Bain 1996)—which discounts the average fish price in the market by 30% as an allowance for getting the product to market—production of 15,000 t in 2007, using the average rural buying price of SI$8/kg given above, would be valued at SI$84 million.

Locally Based Offshore Catches

Estimates of catches of the four main commercial species of tuna in the Western and Central Pacific Fisheries Corporation (WCPFC) area were made by Forum Fisheries Agency (FFA) using data sourced from the Oceanic Fisheries Programme of the Secretariat of the Pacific Community (SPC) (FFA 2008). In these data, prices are all "delivered" prices in that they reflect the price received at entry to the country in which they are usually sold whether for processing or consumption. Also, bycatch, which is an important component of locally based offshore longline fisheries, is not included.

For longline yellowfin and bigeye tuna, FFA (2008) assumed that 80% of the catch is of export quality and 20% is of nonexport quality. For export quality, Japanese fresh yellowfin and bigeye tuna import prices from Oceania were used, while it was simply assumed that nonexport grade tuna attracted $1.50/kg.

Table 12.3 gives catch and local dockside values for the Solomon Islands tuna fleets. It consists of the FFA estimate adjusted for bycatch and transshipment as noted in the table.

Foreign-Based Offshore Catches

Recent tuna catches in Solomon Islands waters by foreign fishing vessels consisted of 95.5% fish caught by purse seine and 4.5% fish caught by longline (Anon 2008d). Estimated tuna catches and values by foreign-based fleets in Solomon Islands waters are given in Table 12.4, adjusted for bycatch and marketing costs as indicated in the table.

Table 12.3: Tuna Catches by the Solomon Islands National Tuna Fleet

Gear	2000	2001	2002	2003	2004	2005	2006	2007
Catch[a]								
Longline	1,488	520	1,212	1,886	1,511	1,511	1,511	1,511
Purse seine	9,462	13,402	8,489	15,937	16,899	16,916	23,439	18,171
Pole line	2,773	4,074	9,695	10,795	6,882	2,842	6,958	3,937
Total (t)	13,723	17,996	19,396	28,618	25,291	21,268	31,908	23,619
Catch value[b]								
Longline	5,860,197	1,981,586	4,308,386	7,704,545	5,672,119	5,867,781	5,835,867	5,685,347
Purse seine	4,799,935	9,101,617	5,862,011	10,914,759	13,378,930	14,546,856	21,203,550	21,640,324
Pole line	1,531,320	3,236,313	7,415,451	7,810,053	6,166,656	2,560,796	6,724,563	5,327,869
Total $	12,191,452	14,319,516	17,585,848	26,429,358	25,217,704	22,975,433	33,763,981	32,653,540
Total SI$	62,041,446	75,578,121	118,682,842	198,377,172	188,747,955	173,002,024	256,925,661	249,864,889

SI$ = Solomon Islands dollar, t = ton.

[a] The catch has been increased for bycatch: 30% for longline and 5% for purse seine.

[b] Catch value has been adjusted: (i) for longline – reduced by 25% to obtain dockside tuna values; and increased by 10% to account for the sale of bycatch, and (ii) for purse seine – reduced by 15% to allow for transshipping.

Sources: FFA (2008), consultant's estimates.

Table 12.4: Tuna Catches in Solomon Islands Waters by Foreign-Based Fleets, 2007[a]

Tuna Catch	Quantity or Value
Catch	
Total catch of all fleets (t)	114,840
Catch of Solomon Islands fleet (t)	21,484
Catch of foreign fleet (t)	93,356
Catch of foreign fleet, adjusted for bycatch (t)	98,023
Catch value	
Catch value of foreign fleet ($)	180,645,727
Catch value of foreign fleet ($), adjusted for transshipment	153,548,868
Catch value of foreign fleet, adjusted for transshipment (SI$)	1,174,648,841

SI$ = Solomon Islands dollar, t = ton.

[a] Catches were increased by 5% to account for bycatch. The values given by Forum Fisheries Agency (FFA) (destination market prices) were reduced by 15% for transshipment, costs to destination markets, and others.

Sources: FFA (2008) and SPC (unpublished information).

Freshwater Catches

The many large islands in the country result in a relatively large inland population with no direct access to marine food resources, which is why the Solomon Islands have a significant subsistence freshwater fishery (Coates 1996). The catch includes flagtails, gobies, and freshwater mullets on Choiseul Island (Boseto et al. 2007); and impressive harvests of tilapia, at times in excess of 16 t/year, from Lake Tenaggano on the island of Rennell (Nelson and Eldredge 1991).

Apart from occasional sales of wild-caught freshwater prawns (*Macrobrachium lar*) and eels (*Anguilla* sp.) (Gillett 2002), freshwater fisheries production is used for subsistence purposes.

Without much factual basis, the production of freshwater fisheries is deemed to be 2,000 t with a farm-gate value of SI$11,200,000.

Aquaculture

The aquaculture situation in the Solomons Islands was summarized as follows (Lindsay 2007).

> "There has been a wide range of species cultured within the Solomon Islands, including giant clams, penaeid shrimps, freshwater prawns,

pearl oysters, sea weed, bêche de mer, hard and soft coral, milkfish, sponges and the capture/culture of post larval animals. To date, the aquaculture industry has had limited contribution to the livelihoods of the rural sector. Since the political unrest within the nation the commercial aquaculture operations have been closed with little private sector interest in restarting operations. Coral culture (hard and soft) has provided small scale sustained economic benefits through the successful development of community based farms that service the private sector aquarium companies. Similarly, seaweed, although still in its development stage, has provided positive indications that the industry may become viable in the long term."

Recent annual aquaculture production in the Solomon Islands is given in Table 12.5.

Summary of Harvests

Table 12.5: Aquaculture Production, Solomon Islands, 2005 and 2006

	2005		2006	
Item	**Quantity**	**Value** (SI$)	**Quantity**	**Value** (SI$)
Post-larvae capture and/or culture	1,386 pieces	8,854	1,202 pieces	7,554
Coral	1,800 pieces	14,400	7,000 pieces	56,000
Seaweed	320 t	640,000	165 t	247,000
Total	**3,186 pieces 320 t**	**663,254**	**8,202 pieces 165 t**	**310,554**

SI$ = Solomon Islands dollar, t = ton.

Note: Values are farm gate or producer price.

Sources: Lal and Kinch (2005), Lindsay (2007), SPC (2007b), and Cospi (2008).

A crude approximation of annual production and value in 2006 is given in Table 12.6. The extremely weak factual basis for the estimates of coastal commercial, coastal subsistence, and freshwater catches is acknowledged.

Table 12.6: Annual Fisheries and Aquaculture Harvest, Solomon Islands, 2007

Harvest Sector	Quantity (t)	Value (SI$)[a]
Coastal commercial	3,250	25,300,000
Coastal subsistence	15,000	84,000,000
Offshore locally based	23,619	249,864,889
Offshore foreign-based	98,023	1,174,648,841
Freshwater	2,000	11,200,000
Aquaculture[b]	8,202 pieces plus 165	311,000
Total	**8,202 pieces plus 142,057 t**	**1,545,324,730**

SI$ = Solomon Islands dollar, t = ton.

[a] The values in the table are dockside and/or farm-gate prices, except in the case of offshore foreign-based fishing where the value in local waters (overseas market prices less imputed transshipment costs) is given.

[b] Aquaculture data are for 2006, the latest available.

Source: Production tables above and consultant's estimates.

Contribution of Fishing to GDP

Current Official Contribution

Table 12.7 shows the contribution of fishing to national GDP.

Table 12.7: Fish Contribution to Solomon Islands GDP, Current Prices

Item	2003	2004	2005	2006
Fishing contribution (SI$ million)	177.8	206.0	171.5	208.4
Solomons GDP (SI$ million)	2,497.5	2,807.6	3,129.8	3,497.7
Fishing share of GDP (%)	7.1	7.3	5.5	5.9

GDP = gross domestic product, SI$ = solomon Islands dollar.

Note: 2005 and 2006 figures are provisional.

Source: Statistical Office (2008).

Method Used to Calculate Official Fishing Contribution to GDP

According to the Central Bank of the Solomon Islands (CBSI), during the period of ethnic tension, the Statistics Office of the Ministry of Finance lost its computer files. Subsequently, responsibility for GDP calculations was passed on to the CBSI. Presently, the responsibility is reverting back to the Statistics Office, but this process has not been fully completed (W. Baron, personal communication, August 2008).

The method currently used by the Statistics Office is to partition the fishing sector into formal and informal sectors. The informal sector is divided into monetary and subsistence fishing; the monetary subsector is further divided into outboard motor (OBM) fishing and other marine products. Table 12.8 shows how the value added for each component is determined.

Table 12.8: Components of the Solomon Islands Fishing Sector and Associated Value Added

Subsector	Data Source	2006 Gross Output and Component (SI$ million)
Formal sector	Business survey conducted periodically by the Statistics Office.	GO: n/a IC: n/a VA: 74,498
OBM fishing	GO is from the recent HIES and the IC is determined by an "informal survey."	GO: 88,638 IC: 33,134 VA: 55,504
Other marine products	GO is from the recent HIES and the IC is determined by an "informal survey."	GO: 3,659 IC: 2,337 VA: 1,323
Subsistence fishing	"Village Resources Survey of 1995/96," which apparently used data on number of canoes, average daily catch per canoe, number of canoe fishing days per year, and an assumed value of $7/kg to determine total value of subsistence catch.	GO: 115,305 IC: 38,229 VA: 77,076
Total Value Added (GDP Contribution)		**VA: 208.4 million**

GDP = gross domestic product, GO = gross output, HIES = household income and expenditure survey, IC = intermediate consumption, kg = kilogram, n/a = not available, OBM = outboard motor, SI$ = Solomon Islands dollar, VA = value added.

Sources: J. Gaiafuna (personal communication, August 2008) and unpublished Statistics Office data.

In the above table,

- accuracy of "monetary fishing" estimate is highly dependent on the accuracy of the "informal survey" for which no details are available;
- the VAR for "other marine products" of 0.36 appears very low for this mainly low-technology type of fishing;
- if the gross output of "subsistence fishing" of SI$115.3 million is combined with the average price used in the "Village Resources Survey of 1995/96," the result is a total subsistence catch of 16,472 t, reasonably close to the estimate of 15,000 t made in section 12.1 above.

Alternative Estimate of Fishing Contribution to GDP

Table 12.9 presents an alternative to the official method of estimating fishing contribution to GDP in the Solomon Islands. It is a simple production approach that takes the values of five types of fishing and/or aquaculture activities for which production values were determined and summarized in Table 12.6. This approach also determines the value added by using VARs characteristic of the type of fishing concerned. The VARs were determined by knowledge of the fisheries sector and by use of specialized studies (Appendix 3).

It is not intended that the approach in Table 12.9 replace the official methodology, but rather the results obtained can serve as a comparator to gain additional information on the appropriateness and accuracy of the official methodology—and possibly a need for modification.

Table 12.9: Fishing Contribution to GDP Using an Alternative Approach, 2007

Harvest Sector	**Value** (SI$) (From Table 12.6)	**Value-Added Ratio**	**Value Added** (SI$)
Coastal commercial	22,300,000	0.75	16,725,000
Coastal subsistence	84,000,000	0.90	75,600,000
Offshore locally based	256,926,000	0.52	133,601,520
Freshwater	11,200,000	0.92	10,304,000
Aquaculture	311,000	0.70	217,700
Total			**236,448,220**

GDP = gross domestic product, SI$ = Solomon Islands dollar.

Sources: From Table12.6 and consultant's estimates.

The total value added in Table 12.9 (SI$236.4 million) is about 13% greater than the official value added of SI$208.4 million. Bearing in mind that the years being compared are different (2006 versus 2007), the major differences are that (i) the official contribution from the "formal sector" is very small relative to that made by the "offshore locally based" of the present study, and (ii) the official contribution from the categories of "OBM" and "other marine products" are very large compared to the "coastal commercial category" of the present study.

Export of Fishery Products

Table 12.10 shows exports of fishery products and other commodities in recent years.

Table 12.10: Solomon Islands Exports (SI$'000)

Item	1999	2000	2001	2002	2003	2004	2005	2006	2007
Fish	159,045	41,174	37,336	70,752	92,869	132,052	86,921	145,855	151,392
Logs	250,658	224,422	190,457	254,149	371,394	468,175	510,162	643,574	838,693
Cocoa	24,394	9,277	4,536	27,728	53,186	40,419	64,329	31,444	70,838
Palm oil and kernels	65,144	6,565	237	0	0	0	0	30,719	105,281
Copra	39,290	34,740	432	2,218	7,821	25,549	16,418	14,066	36,768
Minerals	43,986	1,315	354	192	581	2,857	1,335	6,235	6,696
Other	24,850	13,809	15,334	34,970	31,163	55,075	92,473	45,415	75,981
Total	**607,367**	**331,302**	**248,685**	**390,008**	**557,013**	**724,127**	**771,638**	**971,308**	**1,285,651**

SI$ = Solomon Islands dollar.

Source: Central Bank of Solomon Islands (2008).

Table 12.11: Export Sales of Soltai (SI$)

Item	2002	2003	2004	2005	2006
From fishing operations	8,318,986	13,361,215	20,731,011	7,734,912	9,194,467
Canned	2,798,994	2,714,887	3,972,493	7,054,143	7,150,880
Loin	–	–	43,014,653	30,633,250	41,750,181
Smoked	52,725,098	35,054,534	18,178,425	17,378,257	28,928,209
Fishmeal	1,653,291	336,157	468,805	220,756	573,354
Total	**65,496,369**	**51,466,793**	**86,365,387**	**63,021,318**	**87,597,091**

– = not available, SI$ = Solomon Islands dollar.

Source: Soltai (unpublished company data).

The category "fish" was responsible for 15% of all exports in 2006 and 12% in 2007. The vast majority of exports were tuna products. CBSI (2008) stated that "of the total fish export earnings, canned tuna accounted for $43.4 million compared to $15.1 million in 2006, frozen tuna $102.1 million, frozen tuna for sashimi $7.4 million, and other fish products $5.2 million."

Any processing of tuna prior to export is undertaken by Soltai. Table 12.11 gives the export sales of frozen tuna and various types of processed products.

Section 12.1 discussed the non-tuna fishery exports of the Solomon Islands. The major commodities are bêche de mer, trochus, items for the aquarium trade, seaweed, and shark fins. Gold-lip pearl shell, turtle shell, and crocodiles are under a long-term export ban (Lindley 2007). In 2008, the Solomon Islands Marine Mammals Education Centre and Marine Exporters Ltd. airfreighted 28 dolphins to Dubai at a reported value of $200,000 per dolphin (Barclay 2008).

Government Revenue from Fisheries

Access Fees for Foreign Fishing

Annual reports of the Central Bank provide information on access fees actually paid by foreign fleets. For 2006, "Revenue from fishing licenses collected in 2006 rose from $26 million in 2005 to $32 million, owing to the increase in the number of boats as well as an upward revision of license fees at the beginning of the year" (CSBI 2007). For 2007, "the largest contributor [to non-tax government revenue] was the Ministry of Fisheries and Marine Resources, which generated $93.8 million in non-tax revenue, 43.0% of which was from overseas sources" (CBSI 2008).

From these two statements, the amount of the fees paid by foreign fishing vessels for access to the waters of the Solomon Islands is not entirely clear. Barclay (2008) provided some clarification: 2004, SI$29 million; 2005, SI$26 million; 2006, SI$32 million; and 2007, SI$90 million.

The "estimated total revenue and grants" received by the government in 2007 was SI$2,049.2 million (IMF 2008). The SI$90 million in license fees for 2007, therefore, represented 4.4% of the government's total revenue and grants for that year.

Other Government Revenue from Fisheries

In addition to access fees, the government also receives substantial revenue from licensing of domestic vessels, fish export taxes, transshipment fees, and various taxes on fishing companies. Domestic vessel license fees in 2008 paid by the National Fisheries Development Ltd. and Soltai were SI$100,000 and SI$8,000, respectively (MFMR 2008b).

Data on fisheries export taxes collected are not readily available, but the International Monetary Fund (IMF 2005) provided the Solomon Islands export tax rates: "Nature of tax: Levied only on various land and marine fauna shells, gold, metal scrap, logs and lumber, fish, and various agricultural products. The valuation base is the free on board (FOB) price or value of the export, except in the case of timber and some fish where the value for duty is a 'determined value' adjustable from time to time. Exemptions and deductions: spices, coconut, palm trochus, greensnail, and black-lip shells, 30% fresh, chilled, or frozen fish (some) 5%, dried, salted, smoked or cooked fish 20%." A 5% tax on SI$150 million of fish exports amounts to SI$7.5 million.

With respect to transshipment fees, "A total of 121 transshipments by foreign purse seine occurred at the Honiara Port during 2005 and 65,616 t of skipjack and 13,012 t of yellowfin tunas were transshipped…. Substantive revenue amounting to millions of Solomon Islands dollars were collected by the Department from these transshipments" (DFMR 2006).

As an example of taxes of a fishing company, in 2006, Soltai paid SI$1.25 million to the government in duties and taxes[39] (Wilson [2007], quoted in Barclay [2008]).

Employment

The IMF made an estimate of formal employment in the Solomon Islands, including the fisheries component (Table 12.12).

The tuna industry provides many of the formal fishing jobs in the country. Employment in tuna fishing in recent years is shown in Table 12.13.

Nonformal employment in the fisheries sector is extremely important in the Solomon Islands but the available data are fragmented:

- Of the households involved in self-employed commercial activity, 16% are engaged in the sale of fish and other seafood, according to a recent HIES (Statistics Office 2006).

Table 12.12: Formal Employment, Solomon Islands

Item	2001	2002	2003	2004
Formal fishing jobs	5,179	5,030	5,015	5,114
Total formal jobs	42,631	41,067	41,723	42,297
Fishing jobs share of all formal jobs (%)	12.1	12.2	12.0	12.1

Source: IMF (2005).

Table 12.13: Local Employment in the Tuna Industry, Solomon Islands

Item	2002	2006	2008
Local jobs on vessels	464	66	107
Local jobs in shore facilities	422	330	827
Total	**2,888**	**2,402**	**2,942**

Source: Gillett (2008).

39 It is unclear if this is inclusive or exclusive of fish export taxes.

- In addition to subsistence harvesting, semicommercial or artisanal fisheries activities are practiced by an estimated 30,000 people, mainly in nearshore areas, according to an ADB study (Berdach and Llegu 2005).
- Half of all females and 90% of males participate in fishing activities, according to a 2006 SPC Solomon Islands poverty assessment (Llegu 2007).
- Some 83% of households engage in some form of fishing activity (Oreihaka 1997).
- Of the 111,905 people involved in unpaid work in 1999, 5,056 people (93% male) had some involvement with "fishing and related activities," according to the1999 national census.
- There were about 100,000 full-time, part-time, or occasional fishers in the Solomon Islands in early 1990s, according to an FAO estimate (Visser 1997).

Fish Consumption

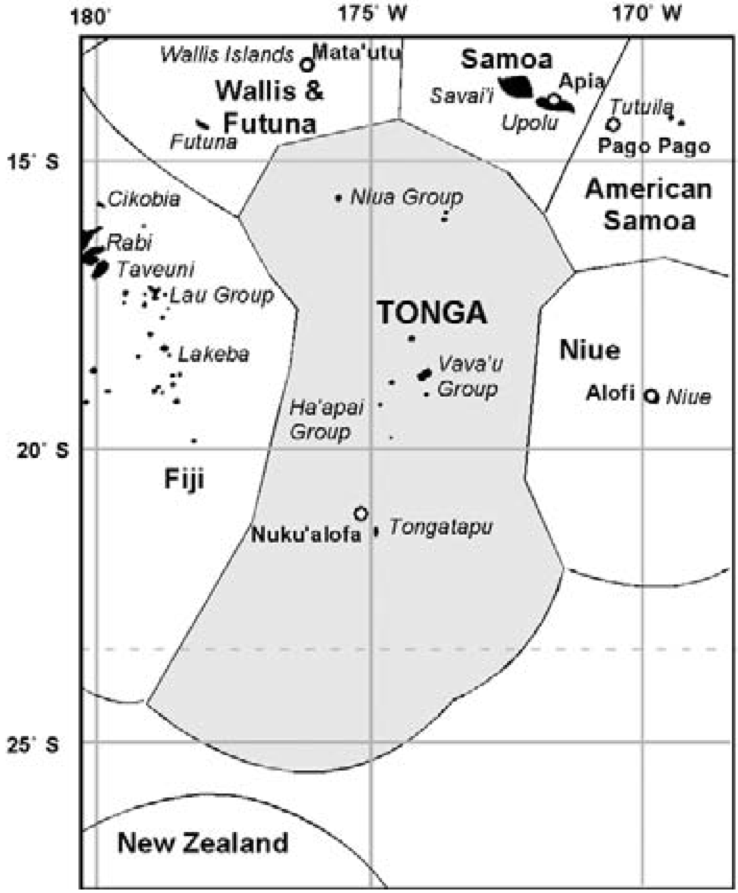
Various estimates of annual per capita fish consumption in the Solomon Islands have been made, as shown in Table 12.14. In some of the studies, the system of measurement (i.e., whole fish equivalent versus food consumed) is not clear.

Table 12.14: Annual Fish Consumption Per Capita in the Solomon Islands

Estimated Annual Per Capita Fish Consumption (kg)	**Comments and Source**
25.7	Ranging from less than 10 kg in rural Guadalcanal and San Cristobal, to 54 kg in the Western Province (Skewes 1990).
40.0	Based on a 1983 estimate (Cook 1988).
45.5	Based on a survey in Honiara in 1992, which found that 31% of households consumed fresh fish each day and that 82.4% of meals containing animal protein were based on fish.
47.9 (Honiara); 65 (provinces)	According to a Japan-sponsored study in 1994.
32.7	For 1995 (Preston 2000).
32.2	According to the FAO Food Balance sheet for 1999.
45.5 (urban); 31.2 (rural)	Based on HIES 2006; fresh fish were 80% in urban areas and 90% in rural areas (Bell et al. 2009).

FAO = Food and Agriculture Organization of the United Nations, HIES = household income and expenditure survey, kg = kilogram.

Tonga



Source: Secretariat of the Pacific Community.

Fish Production

Coastal Commercial Catches

The Fisheries Division does not record total coastal fisheries production, but estimates the quantities and values of the throughput of certain fish markets and of exports. However, estimates of coastal fisheries production in recent years have been made, as follows.

- A total of 1,429 t worth $2,806,641 was estimated for the early 1990s (Dalzell et al. 1996).
- Value added for local market fisheries in late 1990s was T$9,090,000 and for nonmarket fisheries was T$5,108,000, which equated to 2,863 t for nonmarket fisheries and 3,561 t for local market fisheries, according to the Statistics Department, using household income and expenditure survey (HIES) data.
- A total of 4,173 t worth T$17,362,500 was estimated for the late 1990s (Gillett and Lightfoot 2001).

An HIES was carried out during 2000 and 2001 (Tonga Statistics Department [TSD] 2002). Data were collected on income from sales of fish and the imputed noncash income from subsistence fishing:

- Sales of "own fish produce" were estimated at T$29 per capita; consumption of "own fish produce" was imputed to be T$20 per capita.
- Based on population of Tonga in 2001 of 100,672, total income from sale of own fish produce was T$2,901,929 and total imputed income from consumption of own fish was T$2,013,444.
- With selling price for a string of mixed fish of T$4.25/kg (TSD 2007) and farm-gate price for subsistence fish taken at T$2.98/kg, this equated to 683 t for commercial fishing and 676 t for subsistence fishing.

Discussions with the HIES specialist in the SPC Statistics and Demography Programme suggest that Tonga HIES seriously underestimated subsistence fishing (G. Keeble, personal communication, September 2008). For example, the Gillett and Lightfoot (2001) estimates of quantity and value of coastal fisheries production were over five times larger than that estimated by the HIES. For some years, the FOB values of exports from Tonga's coastal fisheries were much greater than the HIES estimates for all commercial coastal fisheries.

In view of these observations, the results of the 2000/2001 Tonga HIES were not used in this study to estimate coastal fisheries production in 2007. Instead, the Gillett and Lightfoot (2001) estimate was updated to account for the following.

- The population of Tonga increased by 3.5%; the price of 1 kg string of fish about doubled; and there was a steady increase in the import of animal foodstuffs (TSD 2007).

- The HIES showed that the four most important single items of cash expenditure on food were mutton flaps, chicken pieces, white bread, and corned beef. This suggests a decrease in cash expenditure on local fish.
- Fishery product export statistics reported to FAO (for which there is some degree of verification using importing country data) show considerable interannual variation, but for coastal fishery products (i.e., non-tuna) there is very little net change in quantity between 2000 and 2006 (the latest year for which such data are available), but there is a 50% increase in value (FAO 2008).

Using the above information, a crude estimate of the production from Tonga's coastal commercial fisheries is 3,700 t (of which about 700 t was exported) worth about T$22.8 million to producers (of which about T$4.8 million were for products that were exported).

Coastal Subsistence Catches

Available subsistence production estimates are 933 t worth $1,901,208 (Dalzell et al. 1996) for the early 1990s and 2,863 t worth T$6,385,000 for the late 1990s (Gillett and Lightfoot 2001). Following the above approach, estimate for production from coastal subsistence fisheries in 2007 was 2,800 t worth T$12,488,000.

Locally Based Offshore Catches

Following the development of domestic longlining in Tonga and the opening of fishery for chartered vessels in late 1990s, the Tonga tuna fleet increased to a peak in 2002 and 2003, but subsequently declined due to poor catch rate and high operations costs. At the end of 2004, all the locally based foreign fishing vessels relocated to other countries (Halafihi and Fa'anunu 2008). Table 13.1 shows the number of licensed fishing vessels registered to fish in Tongan waters during the past 8 years.

Estimates of the volumes and values of the catches of the four main commercial species of tuna in the WCPFC area were made by FFA (FFA 2008), using data sourced from the Oceanic Fisheries Programme of the SPC. In these data, prices are all "delivered" prices in that they reflect the price received at entry to the country in which they are usually sold whether for processing or consumption. Also, bycatch, which is an important component of locally based offshore longline fisheries, is not included.

Table 13.1: Evolution of the Tonga-Based Longline Offshore Fleet

Vessels	2000	2001	2002	2003	2004	2005	2006	2007
Tongan vessels	14	17	18	13	14	15	12	12
Locally based foreign fishing vessels	2	2	2	1	16	14	0	0
Total vessels	**17**	**19**	**19**	**29**	**28**	**15**	**12**	**12**

Source: Halafihi and Fa'anunu (2008).

Table 13.2: Tuna Catches by the Tonga-Based Tuna Fleet

Item	2002	2003	2004	2005	2006	2007
Tuna catch	1,672	971	388	629	760	861
Total catch[a] (t)	2,174	1,262	504	818	988	1,119
Adjusted catch value[b] ($)	4,241,452	2,884,456	1,473,014	2,617,727	2,938,100	3,364,662
Adjusted catch[b] value (T$)	9,288,781	5,884,291	2,842,917	5,261,631	5,934,961	6,224,625

t = ton, T$ = pa'anga.

[a] Catch was increased by 30% for longline bycatch.

[b] For longline catch, the value was reduced by 25% to obtain dockside tuna values (rather than destination market values) and increased by 10% to account for the sale of bycatch.

Sources: Forum Fisheries Agency (2008) and consultant's estimates.

For longline yellowfin and bigeye tuna, FFA (2008) assumed that 80% of the catch was of export quality and 20% was of nonexport quality. For export quality, Japanese fresh yellowfin and bigeye tuna import prices from Oceania were used, while a value of $1.50/kg was assumed for nonexport grade tuna.

Table 13.2 gives local dockside catches and values for the catch of tuna fleets based in Tonga. It consists of the FFA estimate, adjusted for bycatch and transshipment costs as noted in the table.

Foreign-Based Offshore Catches

With the exception of US purse seine vessels fishing under the multilateral treaty, no foreign-based fishing vessels are authorized to fish in Tongan waters. US seiners have not attempted to fish in Tonga in over 20 years.

Freshwater Catches

Catches of fish in freshwater appear limited to tiny amounts of tilapia in small lakes in the three northern island groups of the country. It is reported that a small stream on ‘Eua Island has freshwater shrimp (J. Fa’anunu, personal communication, November 2008) and tilapia were introduced into some of the wells on Ha’ano Island in Ha’apai (Thaman et al. 1995).

Aquaculture Harvests

Recent annual reports of the government fisheries agency give information on aquaculture production:

- Fisheries Department (2007) stated that in 2006 “Aquaculture production for the year was largely carried out by the Ministry of Fisheries. Main projects included enhancement of giant clams, trochus, and green snails. Research trials were aimed at reviving and enhancing over-exploited resources.”
- Fisheries Division (2008a) stated that in 2007 “aquaculture development in recent years has been relatively slow and limited to stock enhancement largely at community level with little significant commercial production…At the end of the year about 12,134 clams equivalent of $33,297 were sold.”

Discussion with the aquaculture staff of the Fisheries Division indicates that pearls are being produced by 3 or 4 people in Vava’u. About 200 pearls are produced each year, with an average value per pearl of T$20 (P. Ngaluafe, personal communication, September 2008).

Summary of Harvests

From the above sections, a crude approximation of annual production and value in 2007 was made (Table 13.3). Note that the factual basis for the estimates of coastal commercial and coastal subsistence catches is extremely weak; and although the harvests are nominally for 2007, given the lack of precision of the estimates of production from coastal commercial and coastal subsistence fisheries, the estimates could easily qualify for the label of “annual harvests, mid-2000s” as used for GDP calculations elsewhere in this report.

Table 13.3: Annual Fisheries and Aquaculture Harvest in Tonga, 2007

Harvest Sector	Quantity	Value (T$)
Coastal commercial	3,700 t	22,800,000
Coastal subsistence	2,800 t	12,488,000
Offshore locally based	1,119 t	6,224,625
Offshore foreign-based	0 t	0
Freshwater	1 t	4,000
Aquaculture	12,334 pieces	37,000
Total	**12,334 pieces plus 7,620 t**	**41,553,625**

t = ton, T$ = pa’anga.

Note: The values in the table are dockside and/or farm-gate prices.

Source: Consultant’s estimates.

Contribution of Fishing to GDP

Official Contribution

The fishing contribution to GDP was determined from unpublished data kindly provided by the Tonga Statistics Department (Table 13.4).

For FY2007, it was projected that fishing would contribute T$23,757,000 to a total GDP of T$505,679,000, with local market component being T$13,203,000; nonmarket T$5,030,000; and export T$5,524,000.

Table 13.4: Official Fishing Contribution to Tonga GDP (T$’000)

Item	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006
Local market component	6,615	7,874	9,120	8,842	10,575	11,645
Nonmarket component	2,520	3,000	3,474	3,368	4,029	4,436
Export component	5,243	6,675	7,488	6,174	6,827	4,067
Total fishing	14,378	17,548	20,082	18,384	21,430	20,148
Total Tonga GDP	288,395	327,036	366,549	391,388	418,696	478,226
Fishing share of Tonga GDP (%)	5.0	5.4	5.5	4.7	5.1	4.2

FY = fiscal year, GDP = gross domestic product, T$ = pa’anga.

Note: GDP at current prices.

Source: Tonga Statistics Department (A. Finau, personal communication, September 2008).

Method Used to Calculate Official Fishing Contribution to GDP

According to the staff of the Statistics Department, the same general method for calculating sector contributions to GDP, including that from fishing, has been used for many years. Gillett and Lightfoot (2001) provided the details on the specific approach to calculating fishing contribution to GDP in Tonga in early 2000. The fishing sector is subdivided into three components:

- **Locally Marketed.** This category covers the fish caught for sale as food. The Statistics Department indicated that a production approach is used to estimate the value added by the locally marketed subsector. Initial data were obtained by surveying some private businesses. The value is updated by extrapolation based on population, consumer price index (CPI), and disaster index. Some 20% of the gross value is subtracted to cover intermediate costs.
- **Nonmarketed.** This category covers the fish and aquatic products harvested for household use. The value added is imputed from information obtained in the HIES. In the years since the HIES, the estimated GDP contributions have been derived by extrapolation based on population, CPI, and disaster index. As with the locally marketed fish, 20% is deducted from the gross output to cover intermediate costs.
- **Export.** The export contribution to estimated GDP comes from the Reserve Bank exports statistics. According to the Statistics Department, the total value of fishery exports is reduced by 35% to account for costs of intermediate inputs.

The general methodology appears sound, but the quality of the estimate depends to a large extent on the accuracy of the HIES and of the survey of "some private businesses." The earlier comment by Gillett and Lightfoot (2001) remains valid:

> "The accuracy of the factors used to adjust for the cost of intermediate inputs could be improved with some input from the fishing sector. The figures used for market fishing (20 percent) and export (35 percent) appear low, while the non-market factor (20 percent) appears high."

Alternative Estimate of Fishing Contribution to GDP

Table 13.5 presents an alternative to the official method of estimating fishing contribution to GDP in Tonga. It is a simple production approach that takes the values of five types of fishing and/or aquaculture activities for which production values were determined and summarized in Table 13.3. This approach also determines the value added by using VARs characteristic of the type of fishing concerned. The VARs were determined by knowledge of the fisheries sector and by use of specialized studies (Appendix 3).

Although information on fisheries production is available through 2007, the latest year for which the Tonga GDP is available is FY2006. As mentioned above, due to lack of precision for the estimates of production from coastal commercial and coastal subsistence fisheries, those estimates are almost equally applicable for FY2006 and are used in Table 13.5.

By contrast, the production estimates for the locally based offshore fishing are relatively accurate. To calculate GDP in FY2006, the value of T$5,600,000 (average of the value of catch for 2005 and 2006) is used in Table 13.5. The annual reports of the government fisheries agencies indicate that aquaculture production has not varied much in recent years.

The total value added from fishing in Table 13.5 (T$24,188,300) is 20% greater than the official estimate of T$20,148,000. The low value added by nonmarket fishing in the official estimate is responsible for most of the difference.

The approach in Table 13.5 does not intend to replace the official methodology, but rather the results obtained can serve as a comparator to gain

Table 13.5: Fishing Contribution to GDP Using an Alternative Approach, FY2006

Harvest Sector	Gross Value of Production (T$, from Table 13.3)	Value-Added Ratio	Value Added (T$)
Coastal commercial	22,800,000	0.60	13,680,000
Coastal subsistence	12,488,000	0.75	9,366,000
Offshore locally based	5,600,000	0.20	1,120,000
Freshwater	4,000	0.95	3,800
Aquaculture	37,000	0.50	18,500
Total (T$)			**24,188,300**

FY = ficsal year, GDP = gross domestic product, T$ = pa'anga.

Sources: Table 13.3 and consultant's estimates.

additional information on the appropriateness and accuracy of the official methodology—and possibly a need for modification.

Export of Fishery Products

Table 13.6 gives exports of fishery products by financial year (July–June) and shows the importance of fishery exports relative to all exports of the country.

The Fisheries Division (2008a) provided information on the commodities that make up Tonga's fishery exports. In 2007, the major exports by value were tuna (29%), live rock (21%), soft coral (12%), snapper (11%), and live fish (10%). Additional details of the commodities exported are given in Table 13.7 constructed from FAO trade data (FAO 2008), for which there is some degree of verification using importing country information.

Table 13.6: Exports of Fishery Products, Tonga

Exports	FY2003	FY2004	FY2005	FY2006	FY2007
Fishery exports (t)	2,945	2,427	3,082	1,952	2,433
Value of fishery exports (FOB, T$ million)	12.2	18.7	11.0	6.5	9.8
Value of total national exports (T$ million)	32.8	38.5	27.1	18.5	20.9
Fishery exports share of total exports (%)	37.2	48.6	40.6	35.1	46.9

FOB = free on board, t = ton, T$ = pa'anga.

Source: Reserve Bank (2008).

Table 13.7: Tonga Fishery Exports as Reported to FAO ($)

Commodity	2004	2005	2006
Miscellaneous corals and shells	1,349	907	1,028
Snapper, fresh, or chilled	1,149	747	849
Other seaweeds and aquatic plants and products thereof	2,247	1,118	776
Yellowfin tuna, fresh, or chilled	214	252	555
Bigeye tuna, fresh, or chilled	118	322	287
Ornamental fish nei	4	58	283
Shark fins, dried, salted, etc.	212	83	281
Marine fish, fresh, or chilled, nei	274	100	277
Albacore, fresh, or chilled	77	56	156
Fish fillets, frozen, nei		158	118

continued on next page

Table 13.7: continuation

Commodity	2004	2005	2006
Mollusks, live, fresh, or chilled, nei	18	44	50
Swordfish, fresh, or chilled	178	87	22
Rock lobsters (*Jasus* species), nei, frozen			20
Seabass, frozen			15
Marine fish, frozen, nei		13	9
Grouper, fresh, or chilled	11	18	7
Other aquatic invertebrates, frozen		.	6
Sea cucumber, dried, salted, or in brine	46	5	5
Mollusks and other aquatic invertebrates, live, fresh, chilled, nei	79	2	3
Mackerels, nei, fresh, or chilled	3	7	2
Yellowfin tuna, frozen, nei	1		2
American/European lobsters (*Homarus* species), nei, frozen			1
Fish waste, nei			1
Ornamental saltwater fish	6	0	1
Total ($ million)	**5,986**	**3,977**	**4,754**
Total (T$ million)	**12,211**	**7,676**	**9,556**

FAO = Food and Agriculture Organization of the United Nations, nei = not elsewhere included, T$ = pa'anga.

Source: FAO (2008).

Table 13.8: Tuna Exports, Tonga (kg)

Species	2002	2003	2004	2005	2006	2007
Albacore	459,133	647,524	127,093	42,616	90,281	87,675
Bigeye	93,423	44,037	25,376	62,351	74,574	73,994
Yellowfin	138,247	120,862	43,543	60,968	130,149	125,302
Moonfish	15,445	4,278	434	22,909	19,416	2,389
Swordfish	7,022	3,413	4,961	10,646	6,522	11,765
Others	62,816	65,443	36,416	39,214	49,324	70,094
Total	**776,086**	**776,086**	**257,823**	**239,704**	**370,266**	**371,219**

kg = kilogram.

Source: Halafihi and Fa'anunu (2008).

Details of Tonga's tuna exports are shown in Table 13.8.

The total annual value of exports of aquarium products—fish, invertebrates, live rock, and live hard/soft coral—increased from about

T$0.9 million in 2001 to a peak of about T$2.8 million in 2005 and then decreased to about T$2.4 million in 2006, mainly due to decrease in total export of live rock and invertebrates (Fa'anunu 2007). Of the Pacific island countries, Tonga is the largest exporter of snapper and other deepwater bottom fish (Gillett 2008b). Exports average about 150 t annually (Wilson 2007).

There are considerable discrepancies in the Tonga fishery export data. Information in the Fisheries Division annual reports is often inconsistent with other documents produced by the Division and with those of the Reserve Bank. Even the Reserve Bank has internal inconsistencies in a single document for fishery export values (e.g., June 2008 Quarterly Report). The values of some exports are significantly less than those given by an external verifiable source. As an example, giant clam exports, given in the 2006 annual report for 2005 and 2006 (Fisheries Department 2007), are far less than those given by CITES (2008).

Government Revenue from Fisheries

Access Fees for Foreign Fishing

With the exception of US purse seiners covered by the multilateral tuna treaty (to which Tonga is a party), no foreign-based vessels are authorized to fish in Tongan waters.

Under the terms of the US multilateral tuna treaty, Tonga and other Pacific island countries receive payments from the Government of the United States and the US tuna industry that are associated with fishing access by US purse seiners. Table 13.9 shows the funds received by Tonga from the treaty for the past 5 years. Some Pacific island countries consider that all payments under the US treaty are for fishing access, while others treat some components (e.g., the PDF shares in Table 13.9) as aid.

The 2007 annual report of the Fisheries Division indicates receipt of T$267,057.86 from the treaty during 2007, which equated to $132,206. The government's FY2008 revenue was T$153 million (Fonua 2008), of which the T$267,057 received in access fees in 2007 is 0.17%.

Other Government Revenue from Fisheries

The recent annual reports of the Fisheries Division/Department have a section titled "Revenue Performance." Those sections are used to construct

Table 13.9: Payments to Tonga from the US Multilateral Treaty ($)

Licensing Period	15% Shares[a]	85% Shares[b]	PDF Shares[c]
20th Period 15 June 2007 to 14 June 2008	145,860.78	0.00	111,125.00
19th Period 15 June 2006 to 14 June 2007	145,860.78	0.00	111,125.00
18th Period 15 June 2005 to 14 June 2006	147,209.70	0.00	111,125.00
17th Period 15 June 2004 to 14 June 2005	147,310.43	0.00	111,125.00
16th Period 15 June 2003 to 14 June 2004	147,357.28	0.00	111,125.00

US = United States.

[a] The "15% shares" ($2,042,050.92 in 2008) are shared equally between all countries that are parties to the treaty.

[b] The "85% shares" ($14,273,117.87 in 2008) are apportioned to countries based on where the catch by US vessels was made. These amounts in the table are zero because US seiners have not attempted to fish in Tonga in over 20 years.

[c] The "PDF shares" ($1,555,750.00 in 2008) are shared equally between all countries that are parties to the treaty for project development work.

Source: Unpublished National Marine Fisheries Service (of the United States) public domain data.

Table 13.10, which gives all non-US treaty revenue received by the Division and/or Department during 2007 and 2008.

Table 13.10: Other Government Revenues from Fisheries

Sources, 2007	Amount Collected, 2007 (T$)
Consumption tax	31,574.31
Sundry revenue, Vava'u	2,230.48
Sundry revenue, Ha'apai	388.00
Sundry revenue, Niua Toputapu	0
Market fees	12,000.00
Sundry revenue	51,437.58
Sales of products and produces[a]	1,294.91
Sundry revenue	65,842.46
Miscellaneous licenses	15,306.34
Total collected 2007	180,074.00
Sources, 2006	**Amount Collected, 2006 (T$)**
Consumption tax	32,914.45
Sundry revenue, Vava'u	2,190.50
Sundry revenue, Ha'apai	4,789.30
Sundry revenue, Niua Toputapu	1,262.79
Market fees	11,000.00
Sundry revenue	40,179.48

continued on next page

Table 13.10: continuation

Sources, 2006	Amount Collected, 2006 (T$)
Sales of produce and products[a]	5,425.85
Sundry revenue	69,120.56
Miscellaneous licenses	31,343.42
Total collected 2006	198,226.35

T$ = pa'anga.

[a] Aquarium items and posters.

Sources: Fisheries Department (2007), Fisheries Division (2008a).

Employment

The 2001 Agriculture Census had a major fisheries component. Table 13.11 gives the numbers and distribution of "fishing households"—a term that is not defined in the document.

Other results of the 2001 Agriculture Census (MAF 2002) relevant to fisheries employment were:

- Some three-fourths (3,943) of the fishing households caught and/or gathered fish mainly for home consumption. Another one-fifth (1,073) reported that, aside from consuming what they had fished, they sold some of the caught and/or gathered aquatic products occasionally. Only 2.2% (114) of the fishing households were engaged in this activity mainly for sale.
- A total of 7,704 persons, 79% of whom were males and 21% were females, were engaged in fishing activities during the week prior to the census.

Table 13.11: Number and Distribution of Fishing Households, Tonga

Location of Households	Number of Households	Number of fishing Households	Proportion of Fishing Households (%)
All Tonga	15,738	5,130	32.6
Tongatapu	10,583	2,393	22.6
Vava'u	2,625	1,337	50.9
Ha'apai	1,298	937	72.2
Eua	863	211	24.4
Niuas	369	252	68.3

Source: Ministry of Agriculture and Fisheries (2002).

- On average, two persons per household were engaged in fishing; 92.2% of these persons were household members and the rest were hired workers.

A 2003 survey of employment showed that 34,561 people were employed in Tonga, of whom 1,050 were employed[40] in the category of "fishing." Fishing employment, therefore, represented 3% of total employment in 2003. Of those employed in fishing, 180 (17%) were females (TSD 2004).

The 2005 Tongan Seafood Socio Economic Survey estimated the numbers of people engaged in fishing activities: Tongatapu, 6,470; Ha'apai, 2,053; Vava'u, 4,375. The survey gave the proportions of self-employed who were fishers: Tongatapu, 5%; Ha'apai, 18%; Vava'u, 7%. Of the households surveyed, about 64% in Tongatapu fished for their own supply of seafood and gifts to others. The corresponding figures for Vava'u and Ha'apai were 80% and 82%, respectively (Tonga Fisheries Project 2005).

For 2007, employment in the commercial fisheries sector was estimated at more than 300 people at any given time, and more than 1,500 fishers were involved in the artisanal fishery sector (Fisheries Department 2007).

Employment in tuna fisheries (fishing and postharvest) in recent years is given in Table 13.12.

Table 13.12: Employment in Tuna Fisheries, Tonga

Item	2002	2006	2008
Local jobs on vessels	161	75	45
Local jobs in shore facilities	85	35	35
Total	**246**	**110**	**80**

Source: Gillett (2008).

Fish Consumption

The state of information on fish consumption in 1998 was summarized as follows:

> "It is difficult to make an accurate assessment of the present level of fish intake in Tonga. Although there was a national nutrition survey in 1986, there have been no national food consumption surveys

[40] Employment in an industry is defined by the study as working at least 1 hour during the week in the industry.

> from which average fish consumption could be derived. The figures published for per capita consumption of fish range from a low of 14.0 kg/year to a high of 102.0 kg/year (implying a production of 10,000 t). Assuming that all the production from inshore fisheries is eaten domestically, and that the best estimate of this in 1995 was 2,362 t,[41] then this would provide a supply of 24.2 kg/year for the 1996 population of 97,500. Integrating the 575 t of imported canned fish gives an overall availability of 30.0 kg/year" (Gillett et al. 1998).

Since then, a locally based offshore fishing fleet has developed in Nuku'alofa and considerable amounts of tuna and bycatch are being consumed in Tonga. Per capita availability of fish from this fleet is shown in Table 13.13, which indicates that the non-exported catch from Tonga's locally based offshore fleet has had a large impact on fish consumption in Tonga.

Annual per capita fish consumption (whole weight equivalent) during 2000–2001 was estimated at 20.3 kg,[42] of which fresh fish made up 80%, based on results of the FY2001 HIES (Bell et al. 2009).

Table 13.13: Per Capita Availability of Catch from Tonga's Locally Based Offshore Fleet

Item	Source of Data	2004	2005	2006	2007
Offshore fleet catch (kg)	Table 13.3	504,000	818,000	988,000	1,119,000
Offshore fleet exports (kg)	Table 13.6	257,823	238,704	370,266	371,219
Offshore fleet catch for local consumption (kg)	Difference between catch and exports above. Assumes all catch is offloaded in Tonga[a]	246,177	579,296	617,734	747,781
Annual per capita availability of Tonga offshore fleet catch (kg)	Local consumption above divided by Tonga population	2.4	5.7	6.1	7.3

kg = kilogram.

[a] Currently, there is no direct offloading of longline fish at ports outside Tonga (B. Holden, personal communication, November 2008).

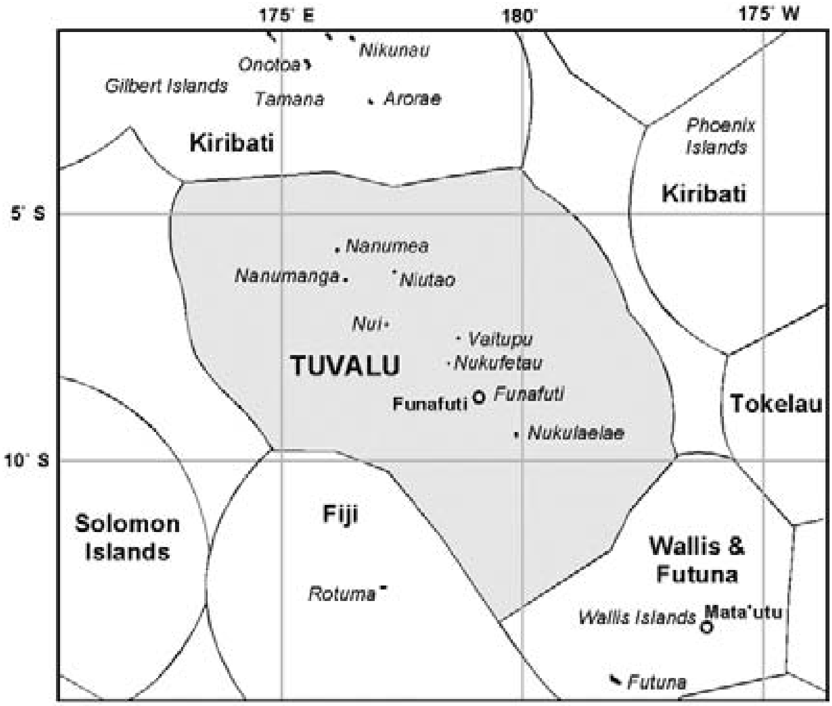
41 This is the Dalzell et al. (1996) estimate for the early 1990s, which Gillett and Lightfoot (2001) considered to be too low.

42 As mentioned above, there are reservations on the accuracy of the Tonga HIES for estimating fisheries production.

An unpublished seafood socioeconomic survey carried out in FY2005 in Tongatapu, Vava'u, and Ha'apai covering 6,423 households revealed that Tongatapu households averaged 2.6 seafood meals per week, while Vava'u and Ha'apai households averaged 2.9 and 3.2 seafood meals per week, respectively (Fisheries Department 2007).

The amount of subsistence and locally marketed coastal fishery production estimated in section 13.1 (about 5,800 t/year) divided by the Tongan population suggests that annual consumption is about 58 kg per capita—substantially more than most recent estimates.

Tuvalu



Source: Secretariat of the Pacific Community.

Fish Production

Coastal Commercial Catches

Coastal commercial fisheries production was estimated at 120 tons (t) worth A$97,811, based on Food and Agriculture Organization of the United Nations (FAO), Secretariat of the Pacific Community (SPC), and unpublished sources from late 1980s and early 1990s (Dalzell et al. 1996).

A total national catch in the order of 1,000 t was estimated in a dried fish marketing study in 1997. The study reported that "Little information is available on the landings of fish in Tuvalu. A statistical program was initiated with assistance from SPC in about 1986, but has not been developed. Some surveys have been undertaken on Funafuti, but overall estimates for the country are probably most reliably derived from the 1994 household survey. This indicates consumption in Funafuti in the order of 60.0 kg per capita and on the islands of around 120.0 kg on average, though there is substantial variation between islands" (SCP 1997).

Coastal commercial catch in 1999 was estimated at 222 t worth A$440,000 by Gillett and Lightfoot (2001), who used the SCP estimate, added 100 t for population growth in 5 years, and assumed that 20% of the total catch was commercial.

Since then, the 2004/2005 HIES produced both documentation (CSD 2006) and unpublished results relevant to estimating coastal fisheries production in Tuvalu. Table 14.1, constructed from unpublished HIES information, indicates a coastal commercial catch of 212 t worth A$497,796.

Although the ratio of commercial fishing to subsistence fishing from the HIES is similar to that from Gillett and Lightfoot (2001), the HIES study gave only 89% of the production of the Gillett and Lightfoot study for a period a half-decade later. Discussions with the HIES specialists in the SPC Statistics and Demography Programme suggest a tendency of HIES to underestimate fish production (G. Keeble, C. Ryan, personal communication, September 2008).

Much of the recent fish consumption information in Tuvalu (section 14.6) comes from HIES studies, so the consumption results do not offer much new insight into judging the accuracy of annual production estimates based on HIES.

For this study, therefore, the estimate of Gillett and Lightfoot (2001) was increased by 2% for population growth over 6 years (SPC 2008a); average fish prices of the HIES[43] were used. Annual coastal commercial production in the mid-2000s is estimated on this basis to be 226 t worth A$733,666.

Coastal Subsistence Catches

Annual coastal subsistence catches in late 1980s and early 1990s were estimated at 807 t worth A$657,781 by Dalzell et al. (1996); in 1999 at 880 t worth A$1,443,200 by Gillett and Lightfoot (2001); and in 2004/2005 as equivalent to 776 t worth A$1,841,375 by the HIES (Table 14.1).

From the above discussion, annual coastal subsistence fisheries production in the mid-2000s is estimated to be 989 t worth A$2,656,896.

43 A$3.24/kg for "purchased fish" and A$2.96/kg for "caught fish."

Table 14.1: Information on Fish Production in Tuvalu from the 2004/2005 HIES

	Annual Expenditure (A$)								
	Urban			Rural			Total		
	Bought	Caught	Urban Total	Bought	Caught	Rural Total	Bought	Caught	Tuvalu Total
Fresh tuna	195,734	157,254	352,988	148,286	967,093	1,115,379	344,020	1,124,347	1,468,367
Reef fish	62,829	196,672	259,501	16,216	418,059	434,274	79,044	614,731	693,775
Other fish	19,135	14,860	33,995	3,493	28,781	32,275	22,629	43,641	66,270
Dried/salt fish	13,104	6,708	19,812	18,876	37,024		31,980	43,732	19,812
Shellfish, etc.	1,196	4,628	5,824	18,927	10,296	29,223	20,123	14,924	35,047
Total	291,998	380,122	672,120	205,798	1,461,253	1,611,150	497,796	1,841,375	2,283,270
	Quantity (kg)								
	Urban			Rural			Total		
	Bought	Caught	Urban Total	Bought	Caught	Rural Total	Bought	Caught	Tuvalu Total
Fresh tuna	83,291	66,917	150,208	63,100	411,529	474,629	146,391	478,446	624,837
Reef fish	26,736	83,690	110,426	6,900	177,897	184,797	33,636	261,587	295,223
Other fish	8,143	6,323	14,466	1,487	12,247	13,734	9,629	18,571	28,200
Dried/salt fish	874	447	1,321	1,258	2,468	0	2,132	2,915	1,321
Shellfish, etc.	1,196	4,628	5,824	18,927	10,296	29,223	20,123	14,924	35,047
Total	120,239	162,006	282,244	91,672	614,438	702,384	211,911	776,443	984,628

A$ = Australian dollar, HIES = household income and expenditure survey, kg = kilogram.

Note: Canned fish quantities and values have been deleted.

Source: unpublished data, courtesy of SPC Statistics and Demography Programme.

Locally Based Offshore Catches

There is presently no locally based offshore fishing in Tuvalu.

In May 2004, two former Republic of Korea longliners arrived in Tuvalu. In November 2004, those vessels began fishing but soon experienced mechanical problems. During their short fishing career in Tuvalu, the almost negligible catch of the vessels did not come close to covering vessel expenses (Gillett and Reid 2005). No catch by those two longline vessels was reported to SPC.

Foreign-Based Offshore Catches

The foreign offshore fleet licensed to fish in Tuvalu waters in 2007 consisted of 96 longliners, 6 pole-and-line vessels, and 155 purse seiners (Tupulaga 2008). The report states “the purse seine fleet alone contributed 98% to the total reported catch.”

Estimates of catches of the four main commercial species of tuna in the WCPFC area were made by FFA (FFA 2008), using data sourced from the Oceanic Fisheries Programme of the SPC. The prices are all “delivered” prices in that they reflect the price received at entry to the country in which they are usually sold whether for processing or consumption.

Tuna catches and values by foreign-based fleets are shown in Table 14.2, in which catches were increased to account for bycatch and values were reduced to account for transshipment costs as noted in the table.

Freshwater Catches

There are no freshwater fisheries in Tuvalu.

Aquaculture Harvests

According to MNR (2008), the Fisheries Department and island communities have undertaken a number of projects and culture trials, but “none of these have resulted in a single working aquaculture project in Tuvalu…there are no functional aquaculture activities.”

A new milkfish culture operation on Vaitupu consisting of two small ponds had not produced any harvests as of September 2008 (S. Finikaso, personal communication, September 2008).

Table 14.2: Estimating Tuna Catches in Tuvalu Waters by Foreign-Based Fleets[a]

Item	2001	2002	2003	2004	2005	2006	2007
Catch of foreign fleet (t)	22,281	28,332	3,499	19,282	14,572	14,873	33,848
Catch of foreign fleet adjusted for bycatch (t)	23,395	29,749	3,674	20,246	15,300	15,616	35,541
Value of foreign fleet tuna catch at destination market ($ million)	21.1	26.6	4.1	23.3	23.2	15.2	48.2
Value of foreign fleet catch adjusted for transshipment ($ million)	17.9	22.6	3.5	19.8	19.7	12.9	40.9
Value of foreign fleet catch adjusted for transshipment (A$ million)	34.9	41.3	5.3	27.0	25.8	17.0	48.7

A$ = Australian dollar, t = ton.

[a] In the table, Forum Fisheries Agency (FFA) values were reduced by 15% for transshipment costs to the destination markets. Catches were increased by 5% to account for bycatch.

Sources: FFA (2008) and consultant's estimates.

Summary of Harvests

From the above sections, a crude approximation of annual production and value in 2007 was made (Table 14.3). The extremely weak factual basis for the estimates of coastal commercial and coastal subsistence catches should be recognized.

Table 14.3: Annual Fisheries and Aquaculture Production, Tuvalu, 2007[a]

Harvest Sector	Quantity (ton)	Value (A$)
Coastal commercial	226	733,666
Coastal subsistence	989	2,656,896
Offshore locally based	0	0
Offshore foreign-based	35,541	48,700,000
Freshwater	0	0
Aquaculture	0	0
Total	**36,756**	**52,090,562**

A$ = Australian dollar.

[a] The values in the table are dockside and/or farm-gate prices, except in the case of offshore foreign-based fishing where the value in local waters (overseas market prices less imputed transshipment costs) is given.

Source: Consultant's estimates.

Although the harvests are nominal for 2007, given the lack of precision of the estimates of production from coastal commercial and coastal subsistence fisheries, the estimates could also represent "annual harvests, mid-2000s" as used for GDP calculations elsewhere in this report.

Contribution of Fishing to GDP

Current Official Contribution

The current official contribution of fishing to the Tuvalu GDP, given in Table 14.4, is that of 2002, the latest year for which GDP has been calculated (S. Malona, personal Communication, September 2008).

Table 14.4: Official Fishing Contribution to Tuvalu GDP (A$'000)

	1997	1998	1999	2000	2001	2002
Market component	63.0	56.3	64.2	73.1	56.3	80.6
Nonmarket component	1,423.0	1,466.3	1,514.0	1,505.9	1,937.3	2,139.4
Total fishing	1,486.0	1,522.6	1,578.2	1,579.0	1,993.6	2,220
Total GDP	18,051.6	20,664.1	21,361.8	21,151.3	24,823.1	26,944.4
Fishing share of GDP (%)	8.2	7.4	7.4	7.5	8.0	8.2

A$ = Australian dollar, GDP = gross domestic product.

Sources: Central Statistics Division; GDP at current market prices.

Method Used to Calculate Official Fishing Contribution to GDP

The current staff of the Central Statistics Division indicated that they were not familiar with the methodology for compiling national accounts. They were awaiting assistance from the Pacific Financial Technical Assistance Centre and expected to have Tuvalu's GDP up to 2006 in 2009. More detailed information on the GDP methodology was not available during the consultant's visit to Funafuti.

Lewington (2004b) indicated that a revision of the Tuvalu national accounts was carried out in late 2003. That work updated the national accounts last compiled in 1999 and provided estimates of GDP by industry and sector groups in current and constant prices for 1996–2002. On fishing, the 2003 revision slightly increased the contribution of subsistence fishing to GDP in 1996–1998, as follows:

"The [fishing] value added in 1998 has changed by 1.3% with slightly larger changes in earlier years estimates. This is the result of a combination of changes brought about by a reappraisal of consumption per household on the outer Islands following the household survey and discussions with local staff, the re-estimation of the number of households fishing by the 2002 Population Census, and linking the unit value of fish to the CPI price change."

Alternative Estimate of Fishing Contribution to GDP

Table 14.5 presents an alternative to the official method of estimating fishing contribution to GDP in Tuvalu. It is a simple production approach that takes the values of five types of fishing and/or aquaculture activities for which production values were determined and summarized in Table 14.3. This approach also determines the value added by using VARs characteristic of the type of fishing concerned. The VARs were determined by knowledge of the fisheries sector and by use of specialized studies (Appendix 3).

Although information on fisheries production is available through 2007 (Table 14.3), the latest year for which the Tuvalu GDP is available is 2002. Due to lack of precision for the estimates of production from coastal commercial and coastal subsistence fisheries, those estimates are almost equally applicable for 2002, and are used in Table 14.5.

The approach in Table 14.5 is not intended to replace the official methodology, but rather the results obtained can serve as a comparator to gain additional information on the appropriateness and accuracy of the official methodology—and possibly a need for modification.

Table 14.5: Fishing Contribution to Tuvalu GDP, 2002, Using an Alternative Approach

Harvest Sector	Gross Value of Production (A$, from Table 14.3)	Value-Added Ratio	Value Added (A$)
Coastal commercial	733,666	0.70	513,566
Coastal subsistence	2,656,896	.85	2,258,362
Offshore locally based	0		0
Freshwater	0		0
Aquaculture	0		0
Total			**2,771,928**

A$ = Australian dollar, GDP = gross domestic product.

Sources: Table 14.3 and consultant's estimates.

The total value added from fishing in Table 14.5 (A$2,771,928) is 25% greater than the official estimate of A$2,220,000. The low value added by "market" fishing in the official estimate is responsible for most of the difference.

Export of Fishery Products

The published export statistics of Tuvalu are not detailed. They are only disaggregated to the level of "Consignment," "Other," or "Sold." Staff of the Central Statistics Division, Customs Department, indicate that "virtually all of the 'Sold' category consists of marine products such as bêche de mer." The staff of the Customs Department indicate that the only significant exports in recent years have been bêche de mer and aluminum scraps (crushed cans), with the latter actually being a reexport.

The latest Biannual Statistical Report (CSD 2008) gives the values for "sold" exports for recent years: 2002, A$76,943; 2003, A$8,759; 2004, A$6,920; 2005, A$2,600; 2006, not available; 2007, A$5,000.

Government Revenue from Fisheries

Access Fees for Foreign Fishing

The foreign fishing access situation in Tuvalu was recently summarized as follows:

> "Typically, licenses are issued to between 50 and 60 longliners each year, and a similar number of purse seiners. Over the period 2001–05, access fees received have varied widely from A$11.9 million in 2001 to a low of A$1.4 million in 2003, with an average of around A$4.5 million/year. Overall, this is a high rate of access fees relative to catch value, but both the high fees and the large year by year variation are mainly due to the revenues received under the US tuna treaty" (MNR 2008).

Table14.6 shows licensed foreign fishing activity in recent years.

The relative importance of foreign fishing access fees to the government budget is shown in Table 14.7, calculated using data from the Ministry of Finance and Economic Planning.

Table 14.6: Licensed Foreign Fishing Vessels in the Tuvalu Zone

Item	2005	2006	2007	2008
Types and numbers of licensed vessels	93 longliners, 7 pole-and-line vessels 140 purse seiners	34 longliners 3 pole-and-line vessels 52 purse seiners	81 longliners 3 pole-and-line vessels 57 purse seiners	42 longliners 3 pole-and-line vessels 126 purse seiners
Participating countries	FSM, Fiji Islands, Japan, Republic of Korea, New Zealand, Papua New Guinea, Taipei,China, and US	Japan, Republic of Korea, Netherlands Antilles, New Zealand, Taipei,China, and US	Japan, Republic of Korea, New Zealand, Taipei,China, and US	Japan, Republic of Korea, New Zealand, Spain, Taipei,China, and US

FSM = Federated States of Micronesia, US = United States.

Source: Fisheries Department, unpublished data.

Table 14.7: Tuvalu Foreign Fishing Access Fees and the National Budget

Year	"Fish licenses" (A$)	Total Government Revenue and Grants (A$)	"Fish Licenses" Share of Total Revenue and Grants (%)	Status of Amounts
1999	9,691,000	25,656,976	37.8	**Actual**
2000	9,480,000	51,236,376	18.5	**Actual**
2001	11,795,000	32,141,096	36.7	**Actual**
2002	8,694,000	45,101,682	19.3	**Actual**
2003	1,449,000	26,839,671	5.4	**Actual**
2004	4,216,000	21,734,932	19.4	**Actual**
2005	3,145,000	22,692,097	13.9	**Actual**
2006	5,232,000	28,571,645	18.3	**Actual**
2007	4,100,000	36,309,173	11.3	**Revised**
2008	**4,100,000**	**37,676,188**	**10.9**	**Framework**

A$ = Australian dollar.

Source: Unpublished data, Ministry of Finance.

From the above table and previous report sections, some observations on foreign fishing in the Tuvalu zone can be made. During 2003–2007, the following were observed:

- access fees averaged A$3.63 million/year and supplied 13.3% of the government's total revenue and grants;
- the revenue from foreign fishing vessels averaged A$201/t of fish caught, or 14.6% of the value of the fish; and
- the average annual payment by the foreign fishing fleets represented A$376 per person in Tuvalu per year.

Other Government Revenue from Fisheries

Apart from foreign access fees, the governments of other Pacific island countries receive various types of revenue from the fisheries sector, including fish transshipment charges, fees on domestic fishing vessels, and export levies on fishery products. No information is available on the amount of such revenue in Tuvalu, if any. Vessels rarely transship in Funafuti; no domestic fishing vessel licensing is required, and no export levies.

In some respect, the fines obtained from prosecution of illegal fishing activity could be perceived as a "benefit." For example, in 2008, Tuvalu received A$200,000 in settlement of a case of fishing by a purse seiner that breached its license conditions (S. Finikaso, personal communication, September 2008).

Employment

In much of the recent documentation on employment in Tuvalu, fishing is not reported individually but is given under "fishing, agriculture, handicrafts," as in the following summary (ADB 2007b).

- In 2002, 15% of the population over 15 years of age had "fishing, agriculture, handicrafts" on a subsistence basis as its "usual/main economic activity."
- In 2002, 2% of the population over 15 years of age had "fishing, agriculture, handicrafts" on a commercial basis as its "usual/main economic activity."
- Involvement in subsistence "fishing, agriculture, handicrafts" increased 4% during 1991–2002, while that on a commercial basis remained constant.

As to fishing employment, the 2002 Population and Housing Census (SPC 2005) reported that

- 67% of all households in Tuvalu were involved in fishing activities, although mainly for their own consumption;
- the highest percentage of households participating in fishing was on Nanumea (95%) and the lowest was on Funafuti (52%);
- commercial fishing was slightly more common in the outer Islands than in Funafuti (10% and 8%, respectively);

- of those households engaged in fishing, most fished only on the reef, especially in Funafuti; however, a large minority (42.5%) of all households fished both inside and outside the reef, while 6% of all households fished only outside the reef; and
- of the 528 people whose main economic activity was fishing, 68 (12.9%) were females.

The 2002 census also contained information on fishing activities performed in the week prior to the census. Unpublished data, kindly provided by the SPC Statistics and Demography Programme, show that of 1,226 Tuvaluan interviewed, 532 participated in fishing during the week before the census (Table 14.8).

Table14.8: Participation in Fishing during the Week Prior to the Census

	Total	Male	Female
Total number of people interviewed	1,266	601	665
Participated in fishing			
• for own/family use only	424	369	55
• for sale only	12	7	5
• for own use and for sale	96	87	9
Did not participate in fishing	734	138	596

Source: Secretariat of the Pacific Community Statistics and Demography Programme, unpublished data.

Gender aspects of participation in fishing activities have been summarized as follows: “Fishing activities of women and children are more concentrated in the inshore area employing simple methods, while men’s activities are more concentrated on deeper areas and the open ocean, employing more sophisticated methods and gear. Although men also extend their activities to include those of women and children, women and children normally cannot perform men’s tasks. This is simply because deep sea fishing in Tuvalu tradition is entirely a male activity. To let females carry out fishing while males stay at home is a disgrace to the entire family” (Finikaso 2004).

Employment in tuna fisheries (fishing and postharvest) in recent years is shown in Table 14.9.

Table 14.9: Employment in Tuna Fisheries, Tuvalu

Item	2002	2006	2008
Local jobs on vessels	59	20	65
Local jobs in shore facilities	36	10	10
Total	**95**	**30**	**75**

Source: Gillett (2008).

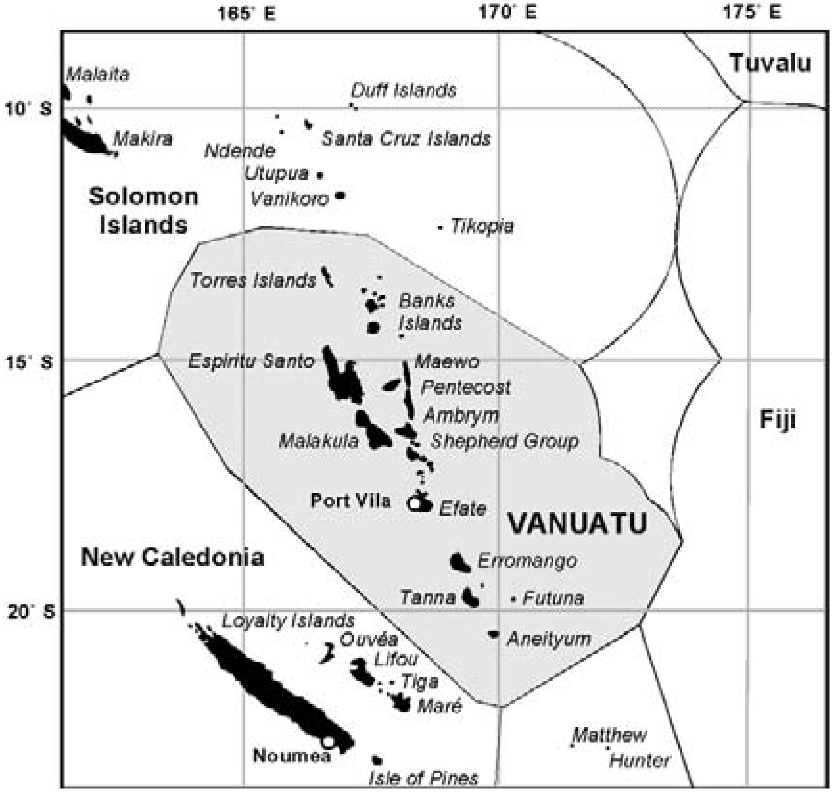
Fish Consumption

Per capita fish consumption is reported to vary from island to island in the range of 100–200 kg/year (MNR 2008).

More detailed estimates of annual fish consumption in Tuvalu include

- 60.0 kg per capita in Funafuti and around 120.0 kg per capita on the outer islands on average, though there was substantial variation between islands (SCP 1997);
- 85.0 kg per capita in 1995, based on FAO production, import, and export statistics (Preston 2000);
- 85.0–146.0 kg in late 1990s, based on credible estimates by various studies (Gillett and Lightfoot 2001); and
- 68.8 kg per capita in urban areas (fresh fish were 97% of this amount) and 147.4 kg per capita in rural areas (99% fresh fish) during 2004 and 2005, based on information from HIES conducted in that period (Bell et al. 2009).

Vanuatu



Source: Secretariat of the Pacific Community.

Fish Production

Coastal Commercial Catches

Coastal commercial fisheries production in Vanuatu was estimated at 467 t worth $1,514,364 in late 1980s and early 1990s (Dalzell et al. 1996). Deepwater snapper provided 80 t/year and shallow water reef fish and coastal pelagic fish 40 t/year, probably worth more than Vt48 million annually. Annual trochus harvests averaging 100 t of shell, with an assumed value of Vt250/kg for the raw shell, were worth a further Vt25 million annually. It was estimated that other smaller fisheries, principally bêche de mer, and to a lesser extent aquarium items, green snail, and crustacean fisheries, contribute at least an additional Vt15 million to local economies annually (Wright 2000). Based on the above studies, coastal commercial fisheries production in late 1990s was estimated at 230 t worth Vt88 million (Gillett and Lightfoot 2001).

Fish production estimated from the 2006 HIES indicated that 336 t of fishery products were purchased in Vanuatu in 2006 (Table 15.1). Other data from the HIES indicated that Vt75.4 million was paid for those purchased fishery products (NSO 2007b).

Coastal commercial production also includes export production and fisheries production for domestic consumption not covered by the HIES. Table 15.2 gives the fishery exports of Vanuatu in 2004. Table 15.3 shows that in 2004–2007, the value of annual exports of the three major commodities averaged $1.2 million (Vt130.4 million). The quantity averaged 52 t and 152,000 pieces. It is assumed (but not explicitly stated in the source documentation) that the values are FOB. Reducing the prices by 30% (i.e., Vt91 million) approximates the prices paid to fishers.

Agriculture censuses were carried out in 2006 and 2007. Those surveys had restricted coverage of fishing activity, limited to household participation in

Table 15.1: Fish Production as Estimated from the 2006 HIES (kg)

Item	Purchased	Caught	Total
Tuna/bonito	2,507	4,988	7,495
Flyingfish	3,078	4,706	7,784
Reef fish	102,439	421,932	524,371
Other fish	138,116	806,525	944,641
Crayfish (lobster)	1,545	17,409	18,954
Octopus, squids	1,339	28,581	29,920
Crabs	2,772	74,569	77,341
Other shellfish	10,446	124,431	134,877
Crabs	73,090	627,575	700,664
Turtle	404	5,704	6,108
Salt fish	0	71	71
Total	**335,736**	**2,116,491**	**2,452,226**

HIES = household income and expenditure survey, kg = kilogram.

Source: SPC unpublished HIES data.

Table 15.2: Fishery Product Exports from Vanuatu, 2004

Item	Quantity	Unit	Value (Vt)
Aquarium fish	129,793	Pieces	24,214,932
Bêche de mer	14,049	kg	13,934,243
Coral	30	Pieces	0
Fish	500	kg	350,000
Giant clams	595	Pieces	687,880
Green snail	227	kg	131,660
Invertebrates	3,791	Pieces	188,790
Live rock	56,400	kg	4,550,100
Shark fins	48	kg	161,472
Soft coral	40	Pieces	18,560
Trochus	35,630	kg	35,146,144
Total			**79,383,781**

kg = kilogram, Vt = vatu.

Source: Fisheries Department (2005).

Table 15.3: Major Fishery Product Exports from Vanuatu, 2004–2007

	Trochus		Bêche de mer		Aquarium products	
	Quantity (t)	Value ($)	Quantity (t)	Value ($)	Quantity (pieces)	Value ($)
2004	35	343,137	13	127,451	130,421	543,139
2005	36	509,803	9	166,666	153,266	892,158
2006	36	700,000	8	180,000	205,117	218,894
2007	55.2	781,050	15.4	135,810	216,466	200,403

t = ton.

Note: Some of the 2007 exports of aquarium products was not from coastal fishing but rather cultured giant clams.

Source: Raubani (2008).

fishing and frequency of fishing. In the analysis of the data, no new estimates of production from fishing were made.

Fisheries production that may have escaped the 2006 HIES includes fish marketed in Port Vila, where relatively affluent local consumers and tourists were unlikely to have been included in the HIES. Catches in early 2000 included 132 t/year of deepwater fish averaging Vt450–500/kg, and 112 t/year of pelagic fish (Hickey and Firiam 2003). For the purpose of the present study, it is assumed that part of the catch of deepwater and pelagic fish was not covered by the HIES: 150 t worth Vt60 million.

The above sources and estimates lead to a total annual production from coastal commercial fisheries of 538 t plus 152,000 pieces worth Vt226.4 million. This estimate is somewhat larger than earlier estimates of coastal commercial fisheries production in Vanuatu, but such fishing activity has expanded in recent years, most noticeably for aquarium products. It also should be noted that factual basis of the current estimate is both independent and stronger than that of previous estimates.

Coastal Subsistence Catches

An estimate of 2,000 t of subsistence fisheries production by Preston (1996b) appears to have become institutionalized (F. Hickey, personal communication, September 2008) and is still quoted in recent documents (e.g., the 2007 annual report of the Fisheries Department). The Preston study credited the estimate to Dalzell et al. (1996), which was based largely on an agriculture survey in 1984. A 2008 Vanuatu trade study (Gay 2008) placed a value on subsistence production of $1,953,360, which is precisely that given by Dalzell et al. (1996). The reality is that no original field research focused on estimating subsistence fisheries production in Vanuatu has been carried out in almost a quarter of a century.

A subsistence fisheries production in 2006 of 2,116 t worth Vt446 million (Vt211/kg) was suggested by the 2006 HIES. However, this appears quite low intuitively as well as in the light of a fisheries study in 1983 (David and Cillaurren 1992), which gave an annual production by village fisheries from near-shore habitats of 2,849 t (F. Hickey, personal communication, September 2008).

Discussions with HIES specialists in the SPC Statistics and Demography Programme suggested a tendency for such surveys to underestimate subsistence fishing (G. Keeble and C. Ryan, personal communication, September 2008). This contention is supported by observations and results from other countries in the present study (e.g., Palau and Tonga).

Some considerations for making a new estimate are

- Subsistence fisheries production in the country was at least four times greater than commercial production (Preston 1996b).
- The population of the country expanded 83% between the period covered by the Dalzell estimate and 2007 (SPC 2008a). Any expansion of subsistence fishing production due to population increase is likely to be at least partially moderated by increasing urbanization.

- The use of modern fishing gear (e.g., spear-guns, cast and gill nets, and powerboats) has also increased significantly since the Dalzell estimate (F. Hickey, personal communication, December 2008).

In this study, with little factual justification, the Dalzell production estimate was increased by half of the population increase since the estimate was made to 2,830 t, about a third larger than the HIES estimate. Taking the value of subsistence fish derived from the HIES (Vt211/kg), a subsistence fisheries production of 2,830 t was valued at Vt597 million.

Locally Based Offshore Catches

There have not been any locally based offshore fishing vessels in Vanuatu for several years. The two "local commercial vessels" mentioned in the 2007 annual report of the Fisheries Department (Raubani 2008) target snappers and groupers and are included in the "coastal commercial" category above.

Foreign-Based Offshore Catches

Information on catches in the Vanuatu EEZ by foreign-based offshore fishing vessels was given in Fisheries Department (2008). The fleet from the People's Republic of China was dominant, both in terms of vessel numbers and capacity, followed by vessels from Taipei,China, then Fiji Islands.

Estimates of catches and values of the four main commercial species of tuna in the WCPFC area for 1997–2007 were made by FFA (FFA 2008), using data sourced from the Oceanic Fisheries Programme of the SPC. The prices used were all "delivered" prices in that they reflected the price received at entry to the country in which they were usually sold whether for processing or consumption. Also, bycatch, which is an important component of longline fisheries, was not included.

Offshore catches are estimated in Table 15.4, adjusted for transshipment costs and bycatch[44] as noted in the table.

Freshwater Catches

The Vanuatu Fishery Resource Profiles (Amos 2007) contain extensive information on the country's freshwater fish and invertebrate resources.

44 In 2004 and 2006, there was a very small amount of purse seine catch, 250 t and 186 t, respectively. As the vast majority of catch was by longline gear, bycatch rates appropriate for that gear have been applied.

Table 15.4: Catches of the Foreign-based Offshore Fleet in the Vanuatu Zone [a]

Item	2003	2004	2005	2006	2007
Tuna catch (t)	6,424	6,847	8,884	14,071	9,891
Destination value of tuna catch ($)	22,135,210	21,179,736	30,110,237	51,553,024	30,592,537
Total catch (t)	8,351	8,901	11,550	18,292	12,858
"In-zone" value of total catch ($)	18,814,929	18,002,775	25,593,701	43,820,071	26,003,657
"In-zone" value of total catch (Vt)	2,299,184,324	2,014,510,569	2,789,713,457	4,820,207,768	2,704,380,286

t = ton, Vt = vatu.

[a] In the table, catch is increased by 30% for bycatch; destination values were reduced by 20% for transport to markets and increased by 5% for sale of bycatch.

Source: FFA (2008) with modifications by consultant.

Distribution of freshwater ecosystems is patchy throughout the Vanuatu archipelago, covering only 1.0% of the total land area of approximately 14,763 km^2. The profiles cover 18 families of local freshwater fish, 3 families of introduced fish, and several species of shrimps and crab. According to the profiles, the most important local species are 5 genera of finfish (*Khulia, Lutjanus, Gerres, Monodactylus, Scatophagus*), 4 species of mullets, several species of freshwater eels, several species of *Macrobrachium,* and introduced carp and tilapia.

Recent annual production from freshwater fisheries was estimated at about 80 t/year by an individual with a long historical involvement in Vanuatu fisheries. This individual examined the available freshwater fisheries data and discussed the issue of freshwater fishing with other local fisheries specialists (F. Hickey, personal communication, September 2008).

The price for subsistence fish of Vt211/kg (see subsistence section above) can be applied to 95% of freshwater production. *Macrobrachium* prawns are currently sold in Santo for Vt500/kg. The recent annual production from freshwater fishing of 80 t is estimated to be worth Vt18 million.

Aquaculture Harvests

Recent aquaculture production in Vanuatu is shown in Table15.5.

A private company is culturing the giant clams and has exported over 300 live cultured specimens since 2006. The marine shrimps are being sold

Table 15.5: Recent Aquaculture Production in Vanuatu

Item	2005	2006	2007	Declared Value ($)
Cultured giant clams (pieces)	0	1,310	2,186	17,811
Cultured coral (pieces)	815	1,205	403	8,313
Red tilapia (t)	0	0	12.8	32,000
GIFT[a] tilapia (t)	0	2.0	not available	14,000
Freshwater prawns (t)	0	10.0	not available	200
Marine shrimps[b] (t)	0	16.0	18.0	720,000

t = ton.

[a] Genetically Improved Farmed Tilapia.

[b] Litopenaeus stylirostris.

Note: it is unclear what period is covered by the "declared value."

Source: Fisheries Department (2008).

for Vt2,000–Vt2,200/kg by a local large-scale company established in 2005. Farming trials of *Macrobrachium* by the Department of Fisheries began in mid-2005. The prawns are being sold at Vt1,000–Vt1,500/kg (Hickey and Jimmy 2008).

From the above, a crude approximation of the 2007 harvest is 34 t and 2,500 pieces worth Vt31.6 million ($303,846).

Summary of Harvests

An estimate of the annual quantities and values of the fishery and aquaculture harvests in 2007 are given in Table 15.6. The very weak factual basis for the estimate of the coastal subsistence catch should be recognized.

Contribution of Fishing to GDP

Current Official Contribution

In the national accounts of Vanuatu, the contribution of commercial fishing to GDP is listed as a subcategory under "other commercial agriculture," and that of subsistence fishing under "subsistence agriculture." The nominal and relative contributions of fishing are given in Table 15.7.

Table 15.6: Annual Fisheries and Aquaculture Harvest in Vanuatu, 2007

Harvest Sector	Quantity	Value[a] (Vt)
Coastal commercial	538 t	226,400,000
Coastal subsistence	2,830 t	597,000,000
Offshore locally based	0 t	0
Offshore foreign-based	12,858 t	2,704,380,286
Freshwater	80 t	18,000,000
Aquaculture	2,500 pieces plus 34 t	31,600,000
Total	**2,500 pieces plus 16,340 t**	**3,577,380,286**

t = ton, Vt = vatu.

[a] The values in the table are dockside/farm-gate prices, except in the case of offshore foreign-based fishing where the value in local waters (overseas market prices less imputed transshipment costs) is given.

Source: Consultant's estimates.

Table 15.7: Fishing Contribution to the Vanuatu GDP (Vt'000)

Item	2002	2003	2004	2005	2006	2007
Commercial fishing	42,891	43,207	37,930	52,731	69,773	79,933
Subsistence fishing	285,595	291,879	301,058	304,581	312,926	323,934
Commercial and subsistence fishing	328,486	335,085	338,987	357,312	382,699	403,867
Vanuatu GDP	31,957,255	34,185,474	36,862,712	40,387,256	45,944,314	51,979,579
Fishing share of GDP (%)	1.0	1.0	0.9	0.9	0.8	0.8

GDP = gross domestic product, Vt = vatu.

Source: National Statistics Office unpublished data.

Method Used to Calculate the Official Fishing Contribution to GDP

Staff of the National Statistics Office kindly prepared a memorandum titled "Fish Methodology for GDP Estimates" to explain the methods used to calculate the fishing contribution to GDP. The memo states:

- The VARs used for commercial fishing and subsistence fishing are 0.679 and 0.744, respectively.
- For commercial fishing, the producers' price of the output (fish + crustaceans + shells) is multiplied by the VAR of 0.679 to obtain the value added.

- For subsistence fishing, the output in the base year is multiplied by a "rural population index" and a "seafood index." The value of this output is multiplied by the VAR of 0.744 to obtain the value added.

The calculations for commercial fishing in 2007 are:

- The outputs, which are based on Fisheries Department and exports data, are: fish (Vt60.858 million), crustaceans (Vt0.984 million), and shells (Vt55.724 million). Gross output: Vt117.566 million.
- The value added is the gross output (Vt117.566 million) multiplied by the VAR of .679 = Vt79.933 million.

The calculations for subsistence fishing in 2007 are:

- The value of the subsistence catch from a base year is multiplied by a population index (1.72) and a seafood index (1.97). The gross output is determined to be Vt435.571 million.
- This output is multiplied by the VAR of 0.7437 to obtain a value added of 323.934 million.

Some features of the methodology are not clear: (a) the origin of the subsistence output for the base year, and (b) the origin and function of the "seafood index." Also, the gross output of commercial fishing used in the calculations (which are sourced from Fisheries Department and exports data) is about half of the gross output of commercial fishing determined above using Fisheries Department information, export data, and knowledge of Vanuatu fisheries. A VAR of 0.744 seems low for the mainly low-technology subsistence fishing in Vanuatu. In Appendix 3 of this report, it is determined that nonmotorized fishing in the Pacific often has a VAR of 0.90–0.92.

Alternative Estimate of Fishing Contribution to GDP

Table 15.8 presents an alternative to the official method of estimating fishing contribution to GDP in Vanuatu. It is a simple production approach that takes the values of five types of fishing/aquaculture activities for which production values were determined and summarized in Table 15.6 above. This approach also determines the value added by using VARs characteristic of the type of fishing concerned. The VARs were determined by knowledge of the fisheries sector and by use of specialized studies (Appendix 3).

It is not intended that the approach in Table 15.8 replace the official methodology, but rather the results obtained can serve as a comparator to gain additional information on the appropriateness and accuracy of the official methodology—and possibly a need for modification.

The total value added from fishing in Table 15.8 (Vt696 million) is considerably greater than the 2007 official estimate of Vt404 million. Differences in gross value of fishing (both commercial and subsistence) account for most of the disparity. A fishing contribution of Vt696 million would be 1.3% of Vanuatu's GDP of Vt51,979 million.

Table 15.8: Fishing Contribution to Vanuatu GDP in 2007 Using an Alternative Approach

Harvest Sector	Gross Value of Production (Vt, from Table 15.6)	Value-Added Ratio	Value Added (Vt)
Coastal commercial	226,400,000	0.70	158,480,000
Coastal subsistence	597,000,000	0.85	507,450,000
Offshore locally based	0	0	0
Freshwater	18,000,000	0.90	16,200,000
Aquaculture	31,600,000	0.45	14,220,000
Total			**696,350,000**

Vt = vatu.

Sources: Table 15.6 and consultant's estimates.

Export of Fishery Products

In section 15.1, it was shown that during 2004–2007, the FOB value of annual exports from coastal commercial fisheries, averaging 52 t and 152,000 pieces, was $1.2 million (Vt130.4 million). These figures included the small amount of aquaculture production that was exported (about Vt1 million of clams and coral in 2007). There were no exports from other fishery categories (i.e., offshore locally based fishing); thus, Vt130.4 million was taken as the average annual export of all fishery products from Vanuatu in recent years.

During 2004–2007, the average annual FOB value of all Vanuatu exports was Vt3,853 million (National Statistics Office website). Fishery exports were therefore responsible for about 3.4% of all exports of the country.

Government Revenue from Fisheries

Access Fees for Foreign Fishing

Vanuatu receives payments for two types of foreign fishing in its zone:

- **Longline Fishing.** Foreign longline fleets from the People's Republic of China, Fiji Islands, Republic of Korea, and Taipei,China fish in Vanuatu waters for tuna and tuna-like species under bilateral access agreements. Most of these vessels operate out of American Samoa and Fiji Islands and primarily target albacore tuna for the canneries in American Samoa and Fiji Islands. In 2007, Vanuatu licensed 119 longline fishing vessels (Fisheries Department 2008a).
- **Purse Seine Fishing.** Under the terms of the US multilateral tuna treaty, Vanuatu and other Pacific island countries receive payments from the Government of the United States and the US tuna industry that are associated with fishing access by US purse seiners. Some Pacific island countries consider that all payments under the US treaty are for fishing access, while others treat some components as aid. Fishing by US seiners has not occurred in Vanuatu waters since the 2003/04 licensing period when 217 t of tuna were caught (NMFS unpublished public domain data).

Table 15.9 gives the payments received by Vanuatu in recent years for the foreign fishing activity in its zone. The government had total revenue and grants of Vt9,193.3 million in 2005 and Vt8,668.3 million in 2006 (Gay 2008). Fishing license fees were, therefore, responsible for 1.2% and 1.7% of government revenue in 2005 and 2006, respectively.

Other Government Revenue from Fisheries

Information on other government revenue from fisheries is not readily available. The Fisheries Department annual report of 2007 (Fisheries Department 2008a) lists various sources of revenue. Apart from the fishing license fees given above, the other sources are "other disposal" (Vt220,404 collected in 2007), "total repair fees" (Vt1,118,855), "total permits recoveries" (Vt1,707,905), and "other items revenue" (Vt1,360). The total of this non-access revenue was Vt3,048,524 in 2007.

Table 15.9: Revenue from Foreign Fishing Licenses

Year	Longline Fishing Licenses (Vt)	US Tuna Treaty ($)	Total (Vt)
2003	105,556,760	317,047	144,236,494
2004	70,790,968	258,435	99,735,688
2005	81,230,022	258,334	109,388,428
2006	121,299,188	256,985	149,567,538

Vt = vatu.

[a] The amounts listed are as though all fees are for access. Payments by the US fleet are made for a June/June licensing period. For the purpose of the table, it is assumed that all US payments are received during the first six months of the year in the table.

Source: Hickey and Jimmy (2008), NMFS unpublished public domain data.

Revenue generated from foreign-based Vanuatu-flagged fishing vessels could be considered government revenue from fisheries. The Vanuatu International Shipping Registry is operated on behalf of the government under contract to Vanuatu Maritime Services (VMS). The VMS accounts are not available in the public domain (F. Hickey, personal communication, September 2008). An FFA study was undertaken of the fishing vessels on the registry and associated issues (Preston 2001a) but the results of that study remain confidential to the Government of Vanuatu.

Employment

According to the 2007 agriculture census (NSO 2008b), 72% of the 15,758 rural households in Vanuatu possessed fishing gear and engaged in fishing activities during the previous 12 months. Of the fishing households, 11,577 (73%) fished mainly for home consumption, 4,127 (26%) for home consumption with occasional selling, and 74 (less than 1%) mainly for sale.

The earlier, 2006, census had slightly different findings: 78% of all Vanuatu households (urban and rural) engaged in fishing, with 48% in urban areas and 86% in rural areas.

The report of the 2006 HIES (NSO 2007b) is not very informative with respect to fishing activities. Source of income is only disaggregated to the level of "agriculture, fish, and handicrafts."

The Vanuatu National Marine Aquarium Trade Management Plan contains some mention of income from the marine aquarium trade. It stated that about $19,000/year is paid to resource owners around the western coast of Efate.

Employment in tuna fishing and processing in recent years is shown in Table 15.10.

Table 15.10: Employment in the Tuna Industry

Item	2002	2006	2008
Local jobs on vessels	54	20	30
Local jobs in shore facilities	30	30	30
Total	**84**	**50**	**60**

Source: Gillett (2008).

The above information gives the impression that in Vanuatu there is good recent information on involvement with village-level fishing. Much less is known about employment in commercial fishing/aquaculture and in commercial postharvest activities. The gender aspect of fisheries employment has apparently not received much attention.

Fish Consumption

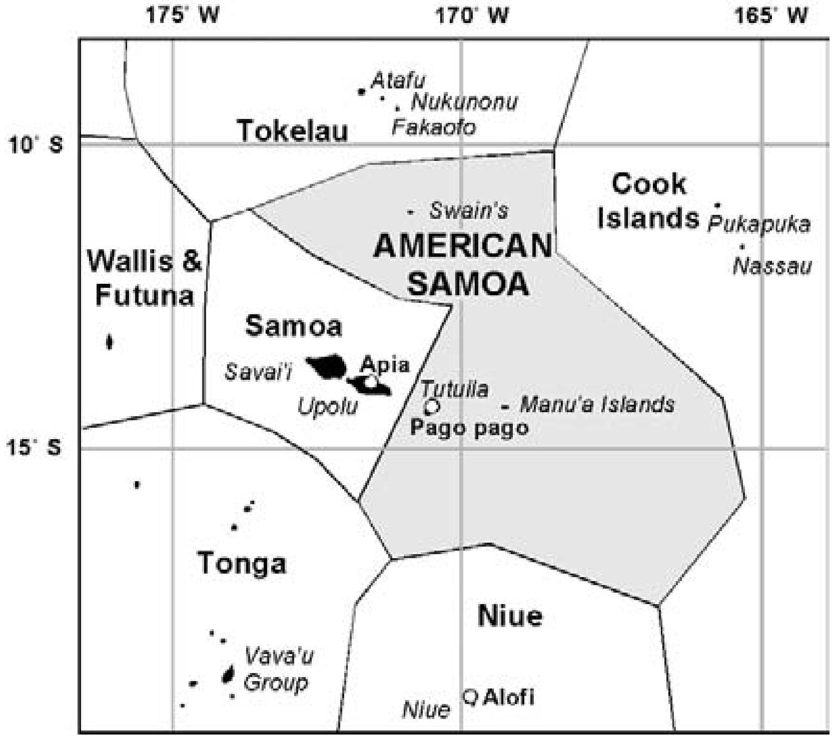
Estimates of annual per capita fish consumption are

- 15.9 kg (fish supply) from coastal fisheries (Preston 1996a);
- 21.0 kg in 1995, based on FAO data and considering production, imports, and exports (Preston 2000);
- 25.7 kg in 2000, considering fishery production, imports, exports, and population (Gillett and Lightfoot 2001); and
- 20.3 kg, of which 60% was fresh fish—20.6 kg for rural areas and 19.3 kg for urban areas, using data from the 2006 HIES (Bell et al. 2009)—although the HIES data may underestimate fish production and consumption (see section 15.1).

PART C

Fishery Benefits in Pacific Island Territories

American Samoa



Source: Secretariat of the Pacific Community.

Fish Production

Coastal Commercial Catches

Annual commercial fisheries production in American Samoa was estimated at 52 t worth $178,762, based on recent literature, including a 1994 Western Pacific Fisheries Information Network (WPacFIN) report (Dalzell et al. 1996). WPacFIN provides access to best available fisheries data from the Western Pacific region.[45] The network monitors the commercial landings in American Samoa, and quantities and values for 1982–2007 are available on the website. Table 16.1 gives these catches in recent years.

[45] According to website information (www.pifsc.noaa.gov/wpacfin).

Table 16.1: American Samoan Commercial Landings

Year	Weight (millions of pounds)	Weight (t)	Value ($ million)
1990	0.079	35.8	0.098
1991	0.105	47.6	0.167
1992	0.132	59.9	0.219
1993	0.089	40.4	0.166
1994	0.317	143.8	0.562
1995	0.414	187.7	0.534
1996	0.449	203.6	0.629
1997	1.035	469.4	1.366
1998	1.309	593.6	1.595
1999	1.145	519.3	1.350
2000	1.839	834.0	1.962
2001	7.994	3,625.3	8.547
2002	15.423	6,994.3	13.823
2003	10.968	4,974.0	10.377
2004	8.935	4,052.0	8.887
2005	8.704	3,947.3	8.546
2006	11.659	5,287.4	11.409
2007	13.952	6,327.2	13.811

t = ton.

Source: Western Pacific Fisheries Information Network (WPacFIN), 2008.

There is difficulty in using the tabled data for the present study because some of the landings are made by large tuna vessels that are in the "offshore locally based" category used in this report. In 2006, 24 of the commercial vessels in the American Samoa pelagic fleet were over 16 meters in length (Hamm et al. 2008).

In this study, it is assumed that the coastal commercial catch of American Samoa has three components, as follows:

- **Pelagic Fishery**. The landings of American Samoan pelagic fishery can be partitioned into longline catch (mainly larger boats, considered locally based offshore) and troll and "other" catch (mainly small boats, considered coastal commercial). For the latter, the 2006 landings were 25,135 pounds (11.5 t) worth $40,946 (dockside) and the 2007 landings were 24,664 pounds (11.2 t) worth $41,384 (WPacFIN unpublished data).

- **Bottom Fish Fishery**. The commercial landings of the bottom fish fishery in 2006 were 6,647 pounds (3.0 t) worth $16,542 and in 2007 were 36,568 pounds (16.6 t) worth $87,025 (WPacFIN unpublished data).
- **Coral Reef Fishery**. Estimating the commercial component of reef fishing is more complex due to difficulty in monitoring and distinguishing the commercial and subsistence components. A recent estimate of the "artisanal reef fishery" catch was 8.4 t/year, with retail market prices for locally caught fish products of $5.51/kg (Spurgeon et al. 2004). Catches in the commercial coral reef fishery of Tutuila were about 10,000 pounds (4.5 t) in 2004 and 19,000 pounds (8.6 t) in 2005 (Fenner et al. 2008).

Selectively using the above information, production from the coastal commercial fishery of American Samoa in 2007 (including the pelagic, bottom fish, and reef components) was estimated to be 34.6 t worth $166,000 to the fishers.

Coastal Subsistence Catches

Production estimates from subsistence fishing in American Samoa are as follows:

- 215 t worth $814,238 for the early 1990s (Dalzell et al. 1996).
- 103 t (Spurgeon et al. 2004).
- 121 t in 2002 (Tutuila 39 t, outer islands 82 t) by Zeller et al. (2006), using a "reconstruction approach" to show a remarkably large decline in subsistence catch rates on the main island of Tutuila over several decades, attributed to overexploitation of the coral reef fish. But this explanation was disputed by several fishery specialists with considerable local knowledge (M. Sabater and D. Hamm, personal communication, September 2008; Sabater and Carroll 2009). However, the Zeller et al. (2006) estimate appears well substantiated.

The average retail price for fresh fish in American Samoa in 2006 was $2.46/pound (about $5.40/kg) (Statistics Division 2008d). Allowing for a price increase over a one-year period and using the "farm-gate" system of valuing subsistence production (discounting by 30%), it was estimated that a subsistence production of 120 t in 2007 would be worth $478,000 to the fishers.

Locally Based Offshore Catches

As stated above, for the purpose of the present study, all longline catches made in American Samoa are considered to be made by the offshore fleet. Unpublished data from WPacFIN shows that the longline catches in 2006 were 5,389 t valued at $11,542,457, and in 2007 were 6,632 t valued at $14,135,083.

Purse seiners and longliners that offload to the cannery are not considered to be locally based. This assertion is mainly based on the fact that the center of their economic activity does not lie in American Samoa; they come to Pago Pago primarily to discharge their catch at a cannery.

Foreign-Based Offshore Catches

There is no foreign fishing in the American Samoa EEZ. US vessels are considered to be domestic vessels. All the longline catch in the zone is considered to be from locally based vessels and is included in the locally based offshore catches above. No purse seine catches have been made in the waters of American Samoa in the last five years (FFA 2008).

Freshwater Catches

Tutuila has about 141 streams that support about a dozen important native species of freshwater fish and invertebrates. The principal groups are eels, gobies, mountain bass, shrimp, and snails (Craig 2005). No catch estimates of the production from freshwater fishing have been made. For the purpose of this study, it is estimated that the annual catch is 1 t worth $4,000.

Aquaculture Harvests

The 2003 agriculture census (USDA 2005) indicated that the 44 tilapia farms in American Samoa sold 6,900 pounds (3.1 t) of fish (worth $14,555) and used 33,670 pounds (15.3 t) of fish (worth $70,716) for family consumption. In 2006, "actual commercial landings" of 3,359 pounds (1.5 t) of tilapia worth $3,984 were reported (Hamm et al. 2008).

There is no marine aquaculture. A facility in Tutuila is in disrepair. Although there is a stock of clams available for spawning, these clams are not being used at present, and their number is declining due to theft (Spurgeon et al. 2004).

It is estimated that in 2007, the total aquaculture production of American Samoa was 9 t, with a farm-gate value of $10,000.

Summary of Harvests

From the above information, crude estimates of fishery and aquaculture harvests in 2007 were made (Table 16.2). These estimates are judged to be accurate, relative to those in this study from other Pacific island countries and territories.

Contribution of Fishing to GDP

Current Official Contribution

The national accounts of American Samoa are at a rudimentary stage of development. In 2005, the US Department of Interior, Office of Insular Affairs renewed its contract with the US Census Bureau to produce estimates of GDP in American Samoa. The primary source of information for making the estimates was the 2002 Economic Census (Rubin 2005), which did not cover the fishing sector (Department of Commerce 2005). The partial 2002 GDP for sectors covered was between $262.6 million and $422.4 million. "When the $166.4 million in value added originating in the excluded sectors of agriculture [and fishing] and government is accounted for, total GDP rises to an estimated $427.0 million–$586.9 million" (Rubin 2005).

Table16.2: Annual Fisheries and Aquaculture Harvest in American Samoa, 2007

Harvest Sector	Quantity (t)	Value[a] ($)
Coastal commercial	35	166,000
Coastal subsistence	120	478,000
Offshore locally based	6,632	14,135,083
Offshore foreign-based	0	0
Freshwater	1	4,000
Aquaculture	9	10,000
Total	**6,797**	**14,793,083**

t = ton.

[a] The values in the table are dockside or farm-gate prices.

Method Used to Calculate the Official Fishing Contribution to GDP

As indicated above, fishing was not considered when making the GDP estimate for 2002.

Estimate of Fishing Contribution to GDP

Table 16.3 shows a way of estimating fishing contribution to GDP in American Samoa. It is a simple production approach that takes the values of five types of fishing or aquaculture activities for which production values were determined and summarized in Table 16.2. This approach also determines the value added by using VARs characteristic of the type of fishing concerned. The VARs were determined by knowledge of the fisheries sector and by use of specialized studies (Appendix 3).

The contribution of fishing to GDP in 2007 estimated in the table ($3.4 million) represents about 0.66% of the $506 million GDP estimate[46] for 2002.

The Zeller et al. (2005) estimation of the contribution of American Samoa's domestic coastal and coral reef fisheries ($585,000 for 2002) can be compared to that of the present study. The present study gives a contribution of $520,840 for coastal commercial and coastal subsistence fishing in 2008—but this includes the contribution from small-scale fishing for pelagic fish

Table 16.3: Fishing Contribution to American Samoa GDP, 2007

Harvest Sector	Gross Value of Production ($, from Table 16.2)	Value-Added Ratio	Value Added ($)
Coastal commercial	166,000	0.69	114,540
Coastal subsistence	478,000	0.85	406,300
Offshore locally based	14,135,083	0.20	2,827,017
Freshwater	4,000	0.90	3,600
Aquaculture	10,000	0.74	7,400
Total			**3,358,857**

GDP = gross domestic product.

Sources: Table 16.2 and consultant's estimates.

46 Midpoint of the $427.0 million–$586.9 million range in Rubin (2005).

($24,830). By removing the pelagic element, a comparable contribution from the present study can be obtained: $496,010. The Zeller estimate is 18% larger.

Export of Fishery Products

Table 16.4 gives the most recent compilation of exports from American Samoa. Fishery products represent virtually all exports from the territory. Canned tuna is by far the most important export commodity. Table 16.5 gives the exports of tuna in recent years. Small amounts of fresh fish are occasionally shipped to Hawaii, but the amounts are insignificant compared to the export of tuna products from the canneries.

Table 16.4: Exports of American Samoa ($)

Item	2003	2004	2005	2006
Aluminum	3,000	0	3,000	0
Fishmeal	3,933,893	1,977,646	195,480	0
Fish oil	52,418	0	0	0
Pet food	7,732,855	42,035,303	21,904,190	7,050,488
Canned tuna	447,818,527	401,576,515	351,708,914	431,478,872
Total exports	459,540,693	445,589,464	373,811,584	438,529,360
Fishery exports share of total exports (%)	99.99	100	99.99	100

Source: Statistics Division (2008d).

Table 16.5: Exports of Canned Tuna (cases)

	2001	2002	2003	2004	2005	2006
Number tuna cases	33,900	22,573	28,855	21,547	21,241	20,656
Value ($'000)	273,652	370,359	477,819	401,577	354,708	431,479

Source: Statistics Division (2008d).

Government Revenue from Fisheries

Access Fees for Foreign Fishing

There is currently no foreign fishing in the American Samoa zone. United States vessels are considered to be domestic vessels.

Other Government Revenue from Fisheries

Fishing licensing fees paid by vessels based in American Samoa go to US government agencies, not to the Government of American Samoa (R. Tulafono, personal communication, September 2008). Information on other forms of government revenue from the fisheries sector in American Samoa, if any, is not readily available.

Employment

Employment in American Samoa directly related to fisheries has two very distinct main components: jobs at tuna canneries and involvement in activities related to domestic fishing and aquaculture.

Cannery employment in 2006 was estimated at 17,395, a slight increase over the 2005 figure of 17,344. The 2006 estimate includes 5,894 government workers, 4,757 cannery workers, and 6,744 employees in the rest of the private sector (Statistics Division 2008d). The canneries provided 27% of all employment in 2006. Employment in local vessels of commercial domestic fishing is shown in Table 16.6.

Data on involvement in subsistence fishing is not readily available. There is a declining proportion of people involved in general subsistence activities (down to 7% in 2000) (Census Bureau 2000). Discussions with fisheries specialists with substantial local experience (M. Sabater and D. Hamm, personal communication, September 2008) also indicate a general downtrend in subsistence fishing in American Samoa in the last few decades. Data on employment in aquaculture is readily available only to the extent that there are 44 “farms” producing fish (USDA 2005).

Table 16.6: Numbers of Vessels and Fishers in American Samoa

Year	Number of Vessels	Number of Fishers
1990	47	94
1991	33	99
1992	27	86
1993	43	146
1994	44	138
1995	44	132
1996	45	135
1997	54	162
1998	52	156
1999	49	147
2000	53	159
2001	73	237
2002	47	141
2003	74	222
2004	56	168
2005	53	159
2006	51	153

Source: Statistics Division (2008d).

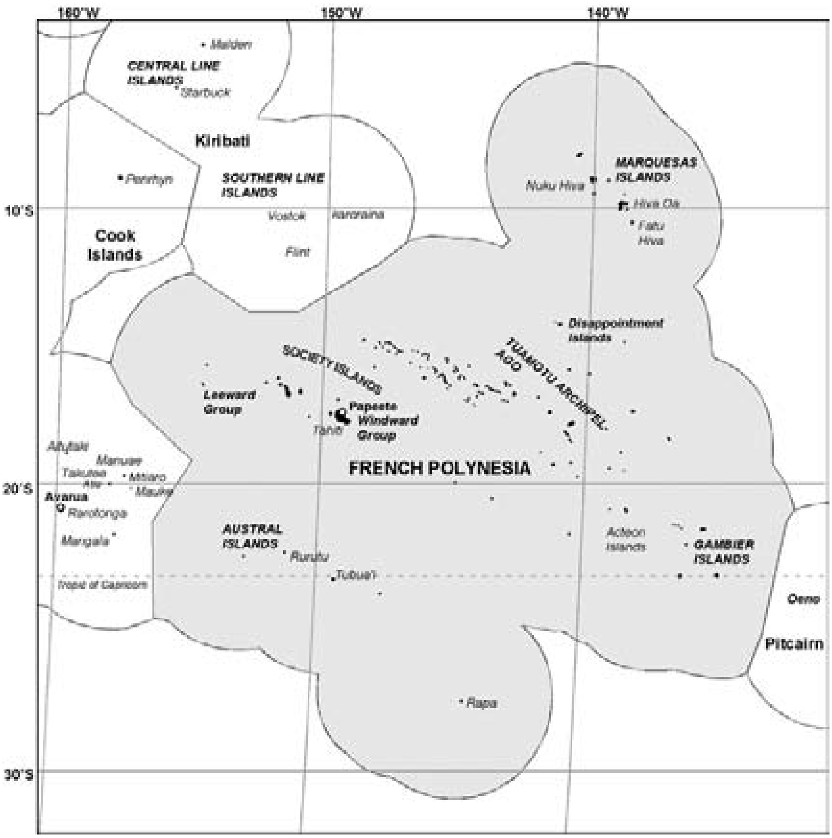
Fish Consumption

Production from coastal fisheries (commercial and subsistence) in American Samoa in early 1990s equated to an annual per capita fish supply of 5.7 kg (Gillett and Preston 1997).

The HIES in 2005 determined that annual per capita fish consumption (whole fish equivalent) was 13.6 kg (SPC unpublished data), but this did not include fish taken for subsistence purposes. If the subsistence catch in 2005 was 120 t, as estimated here, and the population was 63,000 (SPC 2008a), this would add 1.9 kg, to make the total (purchased and subsistence) annual fish consumption of 15.5 kg per capita.

The per capita catch in the outer islands in 2002 was 71 kg, of which 63 kg were consumed and the remainder sent to family members on the main island of Tutuila. The annual subsistence harvest of 37.5 t consisted of the coastal pelagic bigeye scad (*Selar crumenophthalmus*) (31%), reef-associated fish (57%), and invertebrates (12%) (Craig et al. 2008).

French Polynesia



Source: Secretariat of the Pacific Community.

Fish Production

Coastal Commercial Catches

The government fisheries agency in French Polynesia, the Service de la Pêche, groups fisheries into three categories: lagoon, coastal, and offshore. The lagoon and coastal categories together represent the combined coastal commercial and coastal subsistence categories used in the present study.

Coastal commercial fisheries production for 1992 was estimated at 2,352 t worth $14,371,469 (Dalzell et al. 1996). Production from lagoon fisheries in 2007 was estimated to be 4,300 t, made up of 3,400 t of lagoon fish, 700 t of small pelagic fish, and 200 t of other products (mollusks, crustaceans, echinoderms, etc.) worth CFP2 billion to the fishers (Stein 2008). Partitioning the production into commercial and subsistence categories requires an intimate knowledge of the fisheries involved. It is complicated by (a) commercial fishing being carried out by both registered and nonregistered fishers, and (b) the large amount of recreational fishing, especially near Tahiti and Moorea. It is estimated that the 4,300 t catch from lagoon fisheries can be divided into 1,670 t commercial and 2,630 t noncommercial (A. Stein, personal communication, November 2008).

By using the farm-gate system of valuing subsistence production (discounting by 30%), the 1,670 t commercial lagoon catch is estimated to be worth CFP952 million. The 2,630 t noncommercial lagoon catch is estimated to be worth CFP1,050 million.

To obtain the total coastal commercial catch, the above lagoon catch must be added to the catch of both "bonitier" and "poti marara." This category of fishing ("coastal fishery" fleet in the official statistics) requires some clarification because of possible confusion with the "coastal commercial" category of the present study. The Fisheries Department (2008) states:

> "The coastal fishery comprises two types of boat: the *poti marara* (literally 'flying-fish boats'), which are small boats 6-8 m in length, made from wood or FRP and suitable for many different fishing techniques (trolling, vertical longlining or harpooning, operating in the coastal area in the vicinity of 15 nm [nautical miles]), and the *bonitiers* ('skipjack boats'), which are 10- to 12-m long boats made from wood or FRP, targeting skipjack using pole-and-line."

In 2007, the coastal fleet (50 bonitier and 280 poti marara) caught 2,332 t of fish, made up of 667 t from bonitiers, and 1,665 t from poti marara (Service de la Pêche 2008a, 2008b). Staff of the Statistics Unit of the Service de la Pêche gave the value of the 1,665 t poti marara catch at the point of first sale as CFP1,049,400,000 (C. Ponsonnet, personal communication, November 2008). The quantities and values of production from coastal commercial fishing in French Polynesia in 2007 are summarized in Table 17.1.

Coastal Subsistence Catches

The coastal subsistence catch in 1992 was estimated at 3,691 t worth $14,468,720 (Dalzell et al. 1996). As stated above, the 4,300 t catch from lagoon fisheries in 2007 was estimated to consist of 1,670 t commercial and 2,630 t noncommercial.

Not included above is the recreational and "semi-commercial" catch of some several hundred tons made outside the reef but not covered by the statistical system (A. Stein, personal communication, December 2008). For the purpose of the present study, the catches from recreational fishing are considered as production for home consumption and, therefore, as a component of subsistence fisheries. By using the "farm-gate" system of valuing subsistence production (discounting by 30%), the estimated coastal subsistence catch of 2,880 t would be worth CFP1,149,120,000.

Locally Based Offshore Catches

There are two components of the locally based offshore fleet (Fisheries Department 2008b): fresh fish longliners, 11–20 meters in length made of aluminum or FRP, that make day trips; and freezer longliners, 21–26 meter long steel vessels that can remain at sea for up to three months. The catches of the locally based offshore fleet are given in Table 17.2.

Table 17.1: Coastal Commercial Fishing in French Polynesia, 2007

Type of Fishing	Quantity (t)	Value (CFP)
Lagoon fisheries	1,670	952,000,000
Coastal fishery (bonitier and poti marara)	2,332	1,049,400,000
Total	**4,002**	**2,001,400,000**

CFP = Pacific franc, t = ton.

Source: Service de la Pêche (2008a, 2008b), Stein (2008), and Service de la Pêche, unpublished data.

Table 17.2: Catches of the Locally Based Offshore Fleet (t)

Item	2003	2004	2005	2006	2007
Albacore	3,846	2,218	2,426	2,918	3,957
Yellowfin	621	1,066	793	690	527
Bigeye	439	502	606	498	478
Blue marlin	303	243	251	266	327
Wahoo	195	196	243	201	267
Other sharks	280	317	217	123	148

continued on next page

Table 17.2: continuation

Item	2003	2004	2005	2006	2007
Opah	188	150	118	108	122
Dolphin fish	172	129	90	113	109
Striped marlin	117	109	91	122	138
Swordfish	117	86	79	83	67
Miscellaneous	10	75	64	31	65
Oilfish	30	37	26	27	28
Mako shark	49	37	25	26	18
Skipjack	55	72	24	28	30
Pomfret	16	25	21	15	14
Spearfish	15	12	10	9	10
Sailfish	11	5	4	2	2
Black marlin	1	1	0	0	1
Total	**6,468**	**5,278**	**5,087**	**5,258**	**6,308**

t = ton.

Source: Fisheries Department (2008).

Estimates of values for these offshore catches have been made in terms of ranges (C. Ponsonnet, personal communication, November 2008). These are shown in Table 17.3, along with the mid-point values.

Foreign-Based Offshore Catches

In December 2000, all access agreements with foreign fishing fleets ceased (Ponsonnet et al. 2007).

Freshwater Catches

There are 37 species of freshwater fish and 18 species of decapod crustaceans in the territory (Keith et al. 2002). The most important of these for fishery purposes are juvenile gobies (*Sicyopterus lagocephalus* and *S. pugnans*), *Macrobrachium*, tilapia, *Kuhlia* species, and eels. No official estimate has been made of the production from freshwater fishing in French Polynesia, but staff of the Service de la Pêche familiar with the situation indicate that, although catches fluctuate considerably, 100 t/year could be considered an average (A. Stein, personal communication, November 2008) and the value, based on the approach above for subsistence fisheries, would be CFP42.5 million.

Table 17.3: Value of the Catch of the Locally Based Offshore Fleet (CFP '000)

Item	2000	2001	2002	2003	2004	2005	2006	2007
Upper estimate of value	3,027,979	3,372,986	3,040,184	2,768,398	2,401,708	2,297,255	2,351,095	2,706,880
Lower estimate of value	2,412,015	2,810,504	2,588,266	2,285,618	1,847,377	1,780,510	1,811,529	2,208,150
Midpoint of value range	2,719,997	3,091,745	2,814,225	2,527,008	2,124,543	2,038,883	2,081,312	2,457,515

CFP = Pacific franc.

Source: Service de la Pêche unpublished data, courtesy of C. Ponsonnet.

Aquaculture Production

Aquaculture in French Polynesia consists largely of pearl farming, with a much smaller amount of crustacean and finfish culture. There were 792 pearl farms in 2006, down from about three times that number in 2000 (Lo 2007). Production from these farms is not well known due to lack of reporting (C. Lo, personal communication, October 2008).

However, data on official exports of pearls and pearl products are available (Table 17.4). Virtually all exports are raw pearls. It is estimated that 20% of exported pearls are fraudulently exported (IEOM 2008). Undeclared exports are up to 50% of the declared amount (C. Lo, personal communication, October 2008).

Reducing the FOB prices by 30% to approximate farm-gate prices, and adding 30% to the quantity to account for pearl exports not declared, the farm-gate value of pearl production in 2007 of 10,160 kg is estimated to be CFP10.681 million.

In 2007, there was also an aquaculture production of 44.5 t of penaeid shrimp and 1.5 t of finfish (Service de la Pêche 2008a). It is estimated that the farm-gate value of this production was CFP81.6 million.

Total aquaculture production in French Polynesia is estimated to be 56 t worth CFP10,762.6 million.

Summary of Harvests

An approximation of annual production and value in 2007 is given in Table 17.5, from which it is apparent that pearl aquaculture is responsible for 65% of the value of all fisheries and aquaculture production in French Polynesia. As in New Caledonia, the value of production of coastal commercial fishing is similar to that of offshore locally based fishing.

Contribution of Fishing to GDP

Current Official Contribution

The current official contribution of fishing to the GDP of French Polynesia in 2005 is given in Table 17.6.

Table 17.4: Export of Pearls from French Polynesia

Item	2003	2004	2005	2006	2007
Export of pearls and pearl products (kg)	10,115	9,145	8,426	7,690	7,816
Price per gram, FOB (CFP)	1,016	1,238	1,500	1,465	1,393
Value (CFP million)	10,226	11,169	12,359	11,098	10,681

CFP = Pacific franc, FOB = free on board, kg = kilogram.

Source: IEOM (2008).

Table 17.5: Annual Fisheries and Aquaculture Harvest in French Polynesia, 2007

Harvest Sector	Quantity (t)	Value[a] (CFP)
Coastal commercial	4,002	2,001,400,000
Coastal subsistence	2,880	1,149,120,000
Offshore locally based	6,308	2,457,515,000
Offshore foreign-based	0	0
Freshwater	100	42,500,000
Aquaculture	56	10,762,600,000
Total	**13,346**	**16,413,135,000**

CFP = Pacific franc, t = ton.

[a] Values are farm-gate prices.

Source: Consultant's estimates.

Table 17.6: Contribution of Fishing and Aquaculture to the GDP of French Polynesia, 2005

Item	Value (CFP million)
Total fishing and pearl culture value added	5,820
Fishing and shrimp culture valued added	1,521
Pearl culture value added	4,299
French Polynesia GDP	525,934
Share of fishing and pearl culture in GDP (%)	1.1

CFP = Pacific franc, GDP = gross domestic product.

Source: Unpublished data from the Institut de la Statistique de la Polynesie Francaise, courtesy of A. Ailloud.

Method Used to Calculate the Official Fishing Contribution to GDP

According to staff of the Institut de la Statistique de la Polynesie Francaise (ISPF), the contribution of pearl culture to GDP is calculated separately from that of lagoon/coastal/offshore fishing and shrimp aquaculture (A. Ailloud, personal communication, October 2008).

For pearl culture, the FOB export value of pearls and pearl products are multiplied by a VAR to get the value added. This is shown in Table 17.7.

Fishing (lagoon/coastal/offshore) and shrimp aquaculture are considered separate sectors and their contributions to GDP are calculated differently (Table 17.8). The VAR of 0.3361 applies to all the agriculture sector (includes fishing and pearl culture). It was determined by examining the records of 154 companies in the agriculture sector for the year 2005.

Multiplying the total amount paid to fishers (CFP4,525 million) by the VAR gives a total value added (i.e., contribution to GDP) by the fishing and shrimp culture sector in 2005 of CFP1,521 million, the value given in Table 17.6 above.

Some comments on the above methodology are

- For pearl culture, using the FOB price (rather than the farm-gate price) results in an overestimation of the contribution. However, this may compensate to some degree for the pearl exports that are not declared.
- For the fishing and shrimp culture sector, estimates of value added are dependent on accurate amounts of production. The 6,987 t of

Table 17.7: Pearl Culture Contribution to GDP in 2005

Product	FOB Value (CFP)
Raw cultured pearls	12,155,889,996
Raw Keshi pearls	187,877,202
Raw tinted pearls	31,102
Raw Mabe pearls	2,065,291
Worked Keshi	1,087,681
Worked tinted pearls	35,799
Worked Mabe pearls	884,050
Worked other pearls	46,844,802
Pearl shells: worked, raw, or worked	394,788,403
Total FOB value	12,789,504,326
Value Added of Pearl Culture * (Total FOB value x VAR [0.3361])	**4,298,552,404**

CFP = Pacific franc, FOB = free on board, GDP = gross domestic product, VAR = value-added ratio.

Source: Unpublished data from the Institut de la Statistique de la Polynesie Francaise, courtesy A. Ailloud.

Table 17.8: Fishing Contribution to GDP, 2005

Type of fishing	Production (kg)	Retail price (CFP/kg)	Price paid to fishers [a] (CFP/kg)	Total amount to paid to fishers (CFP million)
Tuna	326,763	1,069	792	259
Skipjack	171,007	489	363	62
Small pelagic	557,979	1,662	1231	687
Other	132,976	782	579	77
Total fish	1,188,725	1,232	912	1,084
Shrimp culture	58,500	2,700	2,000	117
Total commercial	1,247,225	1,300	963	1,201
Noncommercial [b]	5,740,000		579	3,324
Grand total	**6,987,225**	**1,300**		**4,525**

CFP = Pacific franc, GDP = gross domestic product, kg = kilogram.

[a] Price paid to fisher is the retail price divided by 1.35.
[b] Production from noncommercial fishing was determined by a survey in 1987.

Source: Unpublished data from the Institut de la Statistique de la Polynesie Francaise, courtesy A. Ailloud.

production used by ISPF for 2005 (Table 17.8) is only about half of the fisheries production of 13,000 t for 2007 estimated in Table 17.5 above.

- Using a single VAR for all types of fishing, aquaculture, and agriculture appears inappropriate. Refining VARs to specific subsectors could give much better estimates of value added.

Alternative Estimate of Fishing Contribution to GDP

Table 17.9 presents an alternative to the official method of estimating fishing contribution to GDP. It is a simple production approach that takes the values of five types of fishing/aquaculture activities for which production values were determined and summarized in Table 17.5. This approach also determines the value added by using VARs characteristic of the type of fishing concerned. The VARs were determined by knowledge of the fisheries sector and by use of specialized studies (Appendix 3). The VAR for pearl culture was determined by examining company accounts of pearl culture operations in the Cook Islands and in Fiji Islands.

It is not intended that the approach in Table 17.9 replace the official methodology, but rather the results obtained can serve as a comparator to gain additional information on the appropriateness and accuracy of the official methodology—and possibly a need for modification.

From the table, a total contribution from fishing/aquaculture of CFP7,206 million is estimated for 2007. In the section above on the official

Table 17.9: Fishing Contribution to GDP in 2007 Using an Alternative Approach

Harvest Sector	Gross Value of Production (CFP, from Table 17.5)	Value-Added Ratio	Value Added (CFP)
Coastal commercial	2,001,400,000	0.55	1,100,770,000
Coastal subsistence	1,149,120,000	0.70	735,000,000
Offshore locally based	2,457,515,000	0.20	491,503,000
Freshwater	42,500,000	0.85	36,125,000
Aquaculture	10,762,600,000	0.45	4,843,170,000
Total			**7,206,568,000**

CFP = Pacific franc, GDP = gross domestic product.

Sources: Table 17.5 and consultant’s estimates.

contribution, an official contribution of CFP5,820 million was estimated for 2005, made up of CFP1,521 million for fishing/shrimp and CFP4,299 million for pearl culture. Bearing in mind that these two estimates are for different years, most of the difference between the estimates originates from the production of coastal/offshore fishing and the VARs applied. It should be noted that reasonably good estimates of fisheries production are available at Service de la Pêche in Papeete.

Export of Fishery Products

Exports of the territory in recent years are given in Table 17.10, from which it can be seen that pearl exports are by far the most significant export of French Polynesia. Undeclared pearl exports (see section 17.1) add further to the importance.

Detailed information on the export of pelagic fish is given in Table 17.11, which shows that pelagic fish make up slightly more than half of the nonpearl fishery exports of the territory.

Table 17.10: Fishery Exports of French Polynesia

	2005	2006	2007
Quantity (t)			
Pearl culture products	8.4	7.7	7.8
Fish, crustaceans	588	635	857
Total fishery exports	596.4	642.7	864.8
Total local exports	21,488	21,239	18,959
Fishery share of total exports (%)	2.8	3.0	4.6
Value (CFP million)			
Pearl culture products	12,359	11,098	10,681
Fish, crustaceans	358	416	488
Total fishery exports	12,717	11,514	11,169
Total local exports	17,204	15,789	15,612
Fishery share of total exports (%)	73.9	72.9	71.5

CFP = Pacific franc, t = ton.

Source: IEOM (2008).

Table 17.11: Pelagic Fish Exports of French Polynesia, 2007

Product form	Type	Whole weight (t)	Net weight (t)	FOB value (CFP million)
Chilled	Loins	169.5	84.7	93.3
	Whole	222.8	222.8	124.0
Frozen	Loins	660.8	331.0	221.2
	Whole	191.0	191	35.2
Processed	Smoked	1.6	0.8	1.2
	Dried	0.1	0.0	0.1
Total		**1,245.7**	**830.3**	**474.9**

CFP = Pacific franc, FOB = free on board, t = ton.

Source: Service de la Pêche (2008a, 2008b).

Government Revenue from Fisheries

Access Fees for Foreign Fishing

No access fees for foreign fishing have been received since December 2000, when all access agreements with foreign fishing fleets ceased (Ponsonnet et al. 2007).

Other Government Revenue from Fisheries

In general, in French Polynesia, the fisheries sector is not revenue generating, but rather subsidy absorbing. Professional fishers are registered and have a license ("*carte*"). All offshore fishers must be registered, whereas registration for coastal fishers is optional. There is no charge for the license, but those with a license are eligible for substantial financial assistance.

Employment

In 2007, there were about 7,000 people employed in pearl culture (IEOM 2008). Table 17.12 gives the number of people involved in fishing activities and nonpearl aquaculture. For 2007, these include 13 people involved in nonpearl aquaculture, 1,800 people in coastal fishing, 1,025 in offshore fishing, and 200 people in freshwater fishing. About 17,500 people were involved with fishing activities in 2007, a significant proportion of the 68,849

Table 17.12: Employment in Fishing in French Polynesia

	Male/Female	2006	2007
Full-time	M	2,049	2,127
	F	144	86
Part-time	M	1,589	1,658
	F	391	408
Occasional	M	4,270	4,270
	F	1,830	1,830
Status not specified	M	200	200
	F		
Total	**M**	**8,108**	**8,255**
	F	**2,365**	**2,324**

Source: Unpublished data, Service de la Pêche.

"declared" jobs in the economy (IEOM 2008) with a total population in 2007 of 259,800 (ISPF 2008).

Fish Consumption

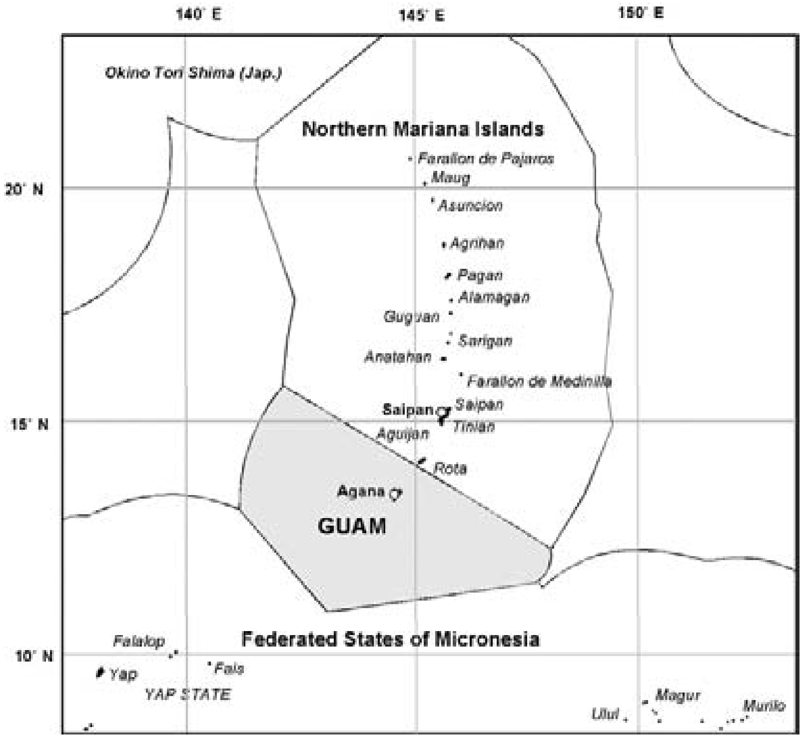
Annual per capita fish consumption in 2003 was estimated at 31.4 kg (Service de la Pêche, unpublished data) based on an estimated domestic fish production of 9,102 t, net weight, fish imports of 790 t,[47] and fish exports of 1,731 t. Domestic fisheries production ("live weight") was reduced by 30% presumably to obtain the actual food weight.

Annual per capita fish consumption in early 2000 was estimated at 70.3 kg, of which 82% was fresh fish. For rural areas the per capita consumption of fish was 90.1 kg, and for urban areas, 52.2 kg. The study used Information from HIES conducted by 15 Pacific countries and territories, mainly between 2001 and 2006, to estimate patterns of fish consumption throughout much of the Pacific. HIES were designed to enumerate fish consumption based on both subsistence and cash acquisitions (Bell et al. 2009).

Even considering that the two studies above are measuring different types of consumption (actual food weight, whole weight equivalent), the results are remarkably different. If the Service de la Pêche results are modified to give whole fish equivalent, the per capita consumption is 46.5 kg/year, compared to 70.3 kg/year in the Bell et al. study.

47 Another source reports that in 2003, total imports of aquatic edible products reached 1,682 t (A. Stein, personal communication, December 2008).

Guam



Source: Secretariat of the Pacific Community.

Fish Production

Coastal Commercial Catches

Annual coastal commercial fishery production in Guam in early 1990s was estimated at 118 t by Dalzell et al. (1996), using information from the Western Pacific Fisheries Information Network (WPacFIN). WPacFIN provides access to best available fisheries data from the Western Pacific region.[48] The network monitors the commercial landings in Guam, and quantities and values for 1982–2007 are available on the website. Table 18.1 gives these catches in recent years.

48 According to website information (www.pifsc.noaa.gov/wpacfin)

Table 18.1: Commercial Landings of Guam

Year	Weight (million pound)	Weight (t)	Value ($ million)
1990	0.313	141.9	0.562
1991	0.314	142.4	0.542
1992	0.325	147.4	0.571
1993	0.374	169.6	0.613
1994	0.397	180.0	0.740
1995	0.409	185.5	0.597
1996	0.292	132.4	0.506
1997	0.357	161.9	0.678
1998	0.549	249.0	1.171
1999	0.494	224.0	1.208
2000	0.609	276.2	1.332
2001	0.617	279.8	1.305
2002	0.486	220.4	0.945
2003	0.359	162.8	0.649
2004	0.397	180.0	0.754
2005	0.358	162.4	0.748
2006	0.335	151.9	0.726
2007	0.097	44.0	0.195

t = ton.

Source: WPacFIN (2008).

The table above shows a large drop in commercial production in 2007. According to staff of the Division of Aquatics and Wildlife Resources, there was a definite reduction in commercial fishing activity in 2007. Higher fuel costs are thought to be at least partially responsible (J. Gutierrez, personal communication, October 2008).

Allen and Bartram (2008) state that, historically, pelagic species dominated Guam's commercial landings, although reef fish became an increasing proportion beginning in 1998.

Discussions with the president of the Guam Fishermen's Cooperative Association indicate that all of the catches in the table for 2007 should be considered nonindustrial in scale. Although the cooperative operates a longline training vessel (the only one in the Guam fishing fleet in recent years), that longliner was not active in 2007 (M. Dueñas, personal communication, October 2008).

It is estimated that the 2007 production from coastal commercial fishing in Guam was 44 t worth $195,000 to the fishers. In 2006, production was more than three times greater—152 t worth $726,000.

Coastal Subsistence Catches

The degree of economic development on Guam is very high relative to most Pacific island countries and territories. This partially explains why partitioning coastal fishing activity into commercial and subsistence components is more difficult in Guam than elsewhere in the region. Because there are few full-time commercial fishers, there is little distinction between commercial, subsistence, and recreational fishing, and many fishing trips contribute to all three segments (Zeller et al. 2007).

Annual subsistence catch for Guam in early 1990s was estimated at 472 t (Dalzell et al. 1996). According to staff of the Division of Aquatics and Wildlife Resources, production by noncommercial fishing is about 40% of that from commercial fishing (J. Gutierrez, personal communication, October 2008). If the commercial catch in 2003–2006 averaged 164 t, this statement implies an annual subsistence catch of 66 t.

A recent household survey of 400 local residents showed that about 40% of the fish and other seafood consumed by the respondents came from noncommercial fishers (VanBeukering 2007). If the commercial catch in 2003–2006 averaged 164 t, this statement implies an annual subsistence catch of 109 t.

Using the above information, subsistence fisheries production in Guam in the mid-2000s is estimated to be around 70 t. Based on the farm-gate system of valuing subsistence production (discounting commercial prices by 30%), it is estimated that a subsistence production of 70 t would be worth $217,000 to the fishers.

Locally Based Offshore Catches

As mentioned above, the Guam Fishermen's Cooperative Association operates a longline training vessel, but that longliner was not active in 2007. (M. Dueñas, personal communication, October 2008)

Several Asian longline vessels unload their catch in Guam. Longliners from Indonesia, Japan, and Taipei,China make port calls in Guam: 96 vessels in 2006 and 97 in 2007 (unpublished data, Bureau of Statistics and Plans).

However, these longliners do not fish in the Guam zone; many use the port of Guam as one of several offloading ports. Also, the center of operations of these longliners is obviously not Guam. Guam government agencies that monitor the longliner activities refer to their port activities as "transshipping." Thus, for the purpose of the present study, it is assumed that in 2007 there was no locally based offshore fishing in Guam.

Foreign-Based Offshore Catches

There is no authorized foreign fishing in Guam zone.

Freshwater Catches

According to the staff of the Division of Aquatics and Wildlife Resources, small amounts of eels and *Macrobrachium* are captured in Guam's streams, plus a somewhat larger amount of tilapia in ponds and in Masso Reservoir (J. Gutierrez, personal communication, October 2008). Statistics are not collected on production from freshwater fishing activities. For the purpose of the present study, it is assumed that in 2007, production from freshwater fishing was 3 t worth $10,000.

Aquaculture Harvests

Aquaculture harvests in 2007 came from 20 hectares of fish ponds and 8 hectares of shrimp ponds, which produced 100 t of tilapia valued at $7/kg, 40 t of milkfish at $7/kg, 10 t of catfish at $6.60/kg, and 12 t of shrimp at $28.75/kg (from data sent to FAO from Bureau of Statistics and Plans). The total was 162 t worth $1,391,000. The price information on the FAO form was for "final consumption." The farm-gate price of cultured shrimp in Guam was $16.50/kg in 2007 (J. Brown, personal communication, October 2008). A semi-arbitrary farm-gate price for finfish of $5/kg was assumed. From the above information, Guam's 2007 aquaculture harvest was 162 t worth $948,000 at the farm gate.

Summary of Harvests

From the above sections, the annual quantities and values of the fishery and aquaculture harvests in 2007 were estimated (Table 18.2). These estimates (except that for subsistence) were judged to be quite accurate, relative to those in this study from other Pacific island countries and territories.

Table 18.2: Annual Fisheries and Aquaculture Harvest in Guam, 2007

Harvest Sector	Quantity (t)	Value[a] ($)
Coastal commercial	44	195,000
Coastal subsistence	70	217,000
Offshore locally based	0	0
Offshore foreign-based	0	0
Freshwater	3	10,000
Aquaculture	162	948,000
Total	**279**	**1,370,000**

t = ton.

[a] The values in the table are dockside/farm-gate prices.

Source: Consultant's estimates.

Contribution of Fishing to GDP

Current Official Contribution

In 2004, the Office of Insular Affairs of the US Department of Interior awarded a contract to the US Census Bureau to produce estimates of GDP in Guam. The primary source of information for making the estimates was the 2002 Economic Census (Rubin and Sawaya 2005a), which did not cover fishing (Department of Commerce 2003).

The partial 2002 GDP for the sectors covered was between $1.927 billion and $2.712 billion, with a best estimate of $2.069 billion. When the $1.359 billion in value added originating from the excluded sectors of agriculture [and fishing], government, airlines, and private education is accounted for, total GDP rises to an estimated $3.286–$4.071 billion (Rubin and Sawaya 2005a). According to officials of the Guam Bureau of Statistics and Plans, these GDP figures are considered "official" by Guam authorities because the figures appear on the US Department of the Interior website (C. Saruwatari, personal communication, October 2008).

Method Used to Calculate the Official Fishing Contribution to GDP

As indicated above, fishing was not considered when making the GDP estimate for 2002.

Estimate of Fishing Contribution to GDP

Table 18.3 presents one option for estimating fishing contribution to GDP in Guam. It is a simple production approach that takes the values of five types of fishing/aquaculture activities for which production values were determined and summarized in Table 18.2. This approach also determines the value added by using VARs characteristic of the type of fishing concerned. The VARs were determined by knowledge of the fisheries sector and by use of specialized studies (Appendix 3). The contribution of fishing to GDP in 2007 in Table 18.3 ($0.9 million) represents about 0.02% of the $3,679 million GDP[49] of Guam for 2002.

Export of Fishery Products

With a large amount of tourism and military activity and a small fisheries sector, the fishery exports of Guam have limited economic importance.

Table 18.3: Fishing Contribution to Guam GDP, 2007

Harvest Sector	Gross Value of Production ($, from Table 18.2)	Value-Added Ratio	Value Added ($)
Coastal commercial	195,000	0.60	117,000
Coastal subsistence	217,000	0.75	162,750
Offshore locally based	0	0.00	0
Freshwater	10,000	0.85	8,500
Aquaculture	948,000	0.65	616,200
Total			**904,450**

GDP = gross domestic product.

Sources: Table 18.2 and consultant's estimates.

49 Midpoint of the $3.286 billion to $4.071 billion range in Rubin and Sawaya (2005a).

Determining the precise quantity is difficult, because any bona fide exports are aggregated in the statistics with the transshipped catch of foreign longliners that make port calls in Guam. The Bureau of Statistics and Plans (2008) gives the export of "Fish, chilled, fresh, frozen, dried and salted" as $11.8 million in 2007, and $4.8 million in 2006. Almost all fishery exports, if not the entire amount, are likely to be from the transshipping longliners.

Most exports of Guam listed in the official statistics appear to actually be reexports. For example, in 2006, the three main exports were motorcars, fish, and iron bars/rods (Bureau of Statistics and Plans 2008).

A significant fishery export that appears to have not been captured in the official statistics is shrimp broodstock. An aquaculture specialist at the University of Guam indicates that in 2007, $140,000 worth of shrimp broodstock was exported (J. Brown, personal communication, October 2008).

Government Revenue from Fisheries

Access Fees for Foreign Fishing

There is currently no authorized foreign fishing in the Guam zone and no access fees are paid. US vessels are considered to be domestic vessels.

Other Government Revenue from Fisheries

Any fishing licensing fees paid by vessels based in Guam go to US government agencies, not to the Government of Guam.

Employment

Guam's 2000 census is of limited use in determining the importance of fisheries employment. The most detailed disaggregation is the category "Agriculture, forestry, fishing and hunting, and mining," in which 212 people were employed in 2000 (Bureau of Statistics and Plans 2005).

Fishery employment in 2007 was given as 1,565 full-time fishers, 60 part-time fishers, and 170 occasional fishers. All these jobs were filled by men (from data sent to FAO from the Bureau of Statistics and Plans).

The number of full-time fishers stated above seems very large compared to the results of other surveys. For example, the Guam Fishermen's Cooperative membership includes 164 full-time and part-time fishers and it processes and markets an estimated 80% of the local commercial catch; nearly all Guam domestic fishers hold jobs outside the fishery; and domestic fishing in Guam supplements family subsistence, which is gained by a combination of small-scale gardening, ranching, and wage work (Allen and Bartram 2008).

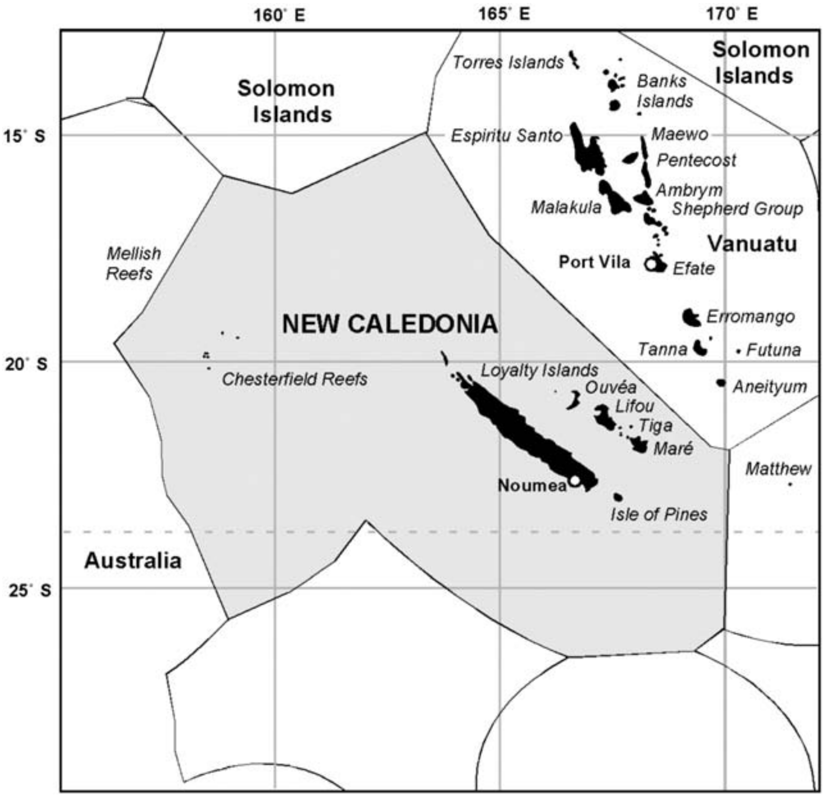
The household survey mentioned earlier (VanBeukering 2007) found that approximately 40% of local residents fished on a regular basis, which was identified to be more important as a social activity rather than an income-generating activity.

Fish Consumption

Production from coastal fisheries (commercial and subsistence) in Guam in early 1990s equated to an annual per capita fish supply of 4.4 kg (Gillett and Preston 1997). In early 2000, annual consumption was estimated at 60 lbs (27.2 kg) per capita (Allen and Bartram [2008] citing Amesbury [2006]).

The household survey (VanBeukering 2007) showed that most households consumed fish approximately twice a week. This had not changed a great deal in the last decade. However, presently, more than half of all consumed fish comes from stores or restaurants, while around 40% comes from immediate or extended family or friends. Some of this is imported fish. Annual seafood imports in 2002 were estimated at 20.9 kg/person (Zeller et al. 2007).

New Caledonia



Source: Secretariat of the Pacific Community.

Fish Production

Coastal Commercial Catches

Coastal commercial fisheries production in 1992 and 1993 averaged 981 t worth $3,968,650, according to Dalzell et al. (1996) using the official New Caledonia catch statistics.

"Declared" commercial production in recent years (SMMPM 2008a, SMMPM 2008b) was 531 t in 2005 worth CFP268 million (at the point of first sale), 679 t in 2006 (worth CFP373 million), and 679 t in 2007.

Discussions with fisheries officials of the South Province indicate that the "declared" catch is substantially less than actual catches. Dupont et al. (2004), a report that synthesizes many aspects of fisheries data, is likely to be the most informative source for the overall production from New Caledonia fisheries (B. Fao, personal communication, August 2008).

Dupont et al. (2004) estimated annual production for 2002 and 2003 at 1,200 t from 492 fishers with 238 fishing vessels. The average price at first sale for production from coastal commercial fisheries in 2006 was CFP549/kg (SMMPM 2007).

Selectively using the above information, it is estimated that in 2007 the coastal commercial fisheries production in New Caledonia was 1,350 t worth CFP756 million at the point of first sale.

Coastal Subsistence Catches

In 1992 and 1993, average annual coastal subsistence catch was estimated at 2,500 t worth $9,000,000 (Dalzell et al. 1996). In 2002 and 2003, the annual average subsistence plus recreational production was given at 3,500 t by Dupont et al. (2004).

In this study, catches from recreational fishing are considered production for home consumption and, therefore, a component of subsistence fisheries. Although the population of the territory has increased about 7% between 2003 and 2008, individuals intimately familiar with the fishing situation in New Caledonia feel that there has been no increase in subsistence fishing (R. Etaix-Bonnin, personal communication, August 2008).

Thus, it is estimated that in 2007 the subsistence fisheries production was 3,500 t worth CFP1,372 million, using the "farm-gate" system of valuing subsistence production (discounting by 30%) to impute the average price for subsistence fish in 2007 at CFP392/kg.

Locally Based Offshore Catches

There were 247 domestic tuna longliners licensed to fish in 2005 and 27 in 2007, of which, 23 vessels were active (Anon 2008e). Offshore production of longline tuna and associated species in 2005 was estimated (SMMPM 2008a, 2008b) at 2,473 t worth CFP870 million at point of first sale, 2,109 t worth CFP740 million at point of first sale in 2006, and 2,122 t in 2007. FFA's estimate for 2007 was 1,770 t of tuna worth $5,566,067 (CFP445 million in destination markets) (FFA 2008).

From the above, it is estimated that the locally based offshore fisheries production in New Caledonia in 2006 was 2,109 t worth CFP740 million, and in 2007 was 2,122 t worth CFP745 million, both at the point of first sale.

Foreign-based Offshore Catches

No licenses to fish have been issued to foreign vessels since early 2001 (Anon 2008e).

Freshwater Catches

Little information is available on freshwater fishing in New Caledonia. An official of Service de la Marine Marchande et des Peches Maritime indicates that all such catches are for subsistence purposes and consist mainly of eels, *Macrobrachium*, and some small species of finfish (R. Etaix-Bonnin, personal communication, August 2008).

A crude estimate of the annual harvest would be about 10 t. Valuing this production similar to the method for coastal subsistence fisheries production above, the 10 t would be worth CFP3,992,000.

Aquaculture Production

Aquaculture in New Caledonia is mainly farming shrimp and oysters, with the shrimp representing over 95% of the value. Official harvest statistics for 2006 were total aquaculture production (shrimp and oyster) of 2,365 t worth CFP1,666 million at the point of first sale (SMMPM 2008a). The corresponding figures for 2007 were total aquaculture production (shrimp, oyster, freshwater crustaceans) of 1,931 t worth CFP1,443.7 million (Anon 2008e).

Summary of Harvests

A crude approximation of the annual harvests and values of the aquaculture harvest in 2007 is given in Table 19.1.

It is interesting to note that in the table above, the total value of the aquaculture harvest is close to that of coastal subsistence, and that the total value of coastal commercial fishing is also close to that of offshore locally based.

Table 19.1: Annual Fisheries and Aquaculture Harvest in New Caledonia, 2007

Harvest Sector	Quantity (t)	Value (CFP)
Coastal commercial	1,350	756,000,000
Coastal subsistence	3,500	1,372,000,000
Offshore locally based	2,122	745,000,000
Offshore foreign-based	0	0
Freshwater	10	3,992,000
Aquaculture	1,931	1,443,700,000
Total	**8,913**	**4,399,092,000**

CFP = Pacific franc, t = ton.

Source: Consultant's estimates.

Contribution of Fishing to GDP

Current Official Contribution

It is not possible to determine the official contribution of fishing to New Caledonia's GDP from the information available in the public domain. The value added from fishing is aggregated with that from agriculture, hunting, forestry, and livestock. The 2007 GDP of New Caledonia was estimated[50] at CFP768.1 billion.

Method Used to Calculate the Official Fishing Contribution to GDP

According to staff of the Institut de la Statistique et des Etudes Economiques (ISEE), a study in 1993 determined that the intermediate consumption of fishing activities in New Caledonia is 73% of the total value of production and that of aquaculture is 71% (A. Durand, personal communication, September 2008). The VARs used by the ISEE for fishing and aquaculture are, therefore, 0.27 and 0.29, respectively. The method used for calculating the contribution to GDP is presumably gross value of production from fishing multiplied by 0.27 and gross value of production from aquaculture multiplied by 0.29 to obtain their respective contributions. The gross values of fisheries/aquaculture production used by ISEE for the calculations are not available in the public domain.

50 By the Institut de la Statistique et des Etudes Economiques. Available: www.isee.nc

Alternative Estimate of Fishing Contribution to GDP

Table 19.3 presents an alternative to the official method of estimating fishing contribution to GDP in New Caledonia. It is a simple production approach that takes the values of five types of fishing/aquaculture activities for which production values were determined and summarized in Table 19.1. This approach determines the value added by using VARs characteristic of the type of fishing concerned. The VARs were determined by knowledge of the fisheries sector and by use of specialized studies (Appendix 3). Some work on VARs for New Caledonia has been done by Dupont et al. (2004) and those for small boats appear in Table 19.2.

Table 19.2: Value-Added Ratios for Small Boat Fishing in New Caledonia

Activity/Location	Value-Added Ratio
Outboard-engine vessels 3.4–4.5 meters in length	0.65
Outboard-engine vessels 5.5–5.5 meters in length	0.80
Inboard-engine vessels 7–8 meters in length	0.65
Inboard-engine vessels 8.4–11.96 meters in length	0.60

Source: Derived from Dupont et al. (2004).

Table 19.3: Fishing Contribution to GDP in 2007 Using an Alternative Approach

Harvest Sector	Gross Value of Production (CFP, from Table 19.1)	Value-Added Ratio	Value Added (CFP)
Coastal commercial	756,000,000	0.65	491,400,000
Coastal subsistence	1,372,000,000	0.80	1,097,600,000
Offshore locally based	745,000,000	0.20	149,000,000
Freshwater	3,992,000	0.90	3,592,800
Aquaculture	1,443,700,000	0.45	649,665,000
Total			**2,391,257,800**

CFP = Pacific franc, GDP = gross domestic product.

Source: Table 19.1 above and consultant's estimates.

Using this VAR information and the value of production from the various types of fishing and aquaculture in New Caledonia (from Table 19.1.), the contributions to GDP were determined (Table 19.3).

The approach in Table 19.3 is not intended to replace the official methodology, but rather the results obtained can serve as a comparator to gain additional information on the appropriateness and accuracy of the official methodology—and possibly a need for modification.

The contribution to GDP in 2007 from fishing/aquaculture of CFP2.4 billion represents 0.3% of the New Caledonia GDP (CFP768.1 billion).

Export of Fishery Products

Values of fishery exports and total exports are shown in Table 19.4.

Government Revenue from Fisheries

Access Fees for Foreign Fishing

No licenses to fish have been issued to foreign vessels since early 2001 (Anon 2008e).

Table 19.4: Exports of Fishery Products and Total Exports (CFP million)

Item	2006	2007
Total fishery exports	18,892	13,651
Tuna	1,231	1,046
Shrimp	15,583	9,287
Bêche de mer	1,156	2,535
Trochus	727	616
Total New Caledonia exports	788,371	1,248,425
Fishery exports share of total exports (%)	2.4	1.1

CFP = Pacific franc.

Source: Institut de la Statistique et des Etudes Economiques (www.isee.nc).

Other Government Revenue from Fisheries

There are both subsidies and taxes applied to commercial fishing activity, but this information is not readily available (B. Fao, Personal communication, August 2008).

Employment

Employment figures for New Caledonia fisheries during 2002/2003 were: lagoon and coastal commercial fisheries, 238 boats and 492 fishers; and industrial fisheries, 29 boats and 288 salaried people including 156 on-board. No estimates were made for subsistence and recreational fisheries (Dupont 2004).

In 2007, official statistics show that 509 registered commercial fishers made trips for lagoon and reef fishing and 170 made trips for offshore fishing (SMMPM 2008b). The number of nonregistered commercial fishers is about equal to those that are registered, according to an individual familiar with New Caledonia fisheries.

Unpublished data from the SPC indicate that 500 people have jobs directly related to aquaculture in New Caledonia (A. Teitelbaum, personal communication, August 2008). The approximately 1,000 people employed in commercial fishing and aquaculture represent about 1.2% of the 80,685 economically active people in the territory.[51] "Economically active" is defined as being those over 14 years of age working during the week prior to the survey.

A survey in three provinces showed that 50% of respondents fished on a subsistence basis 1–3 times per week (Virly 2000).

Fish Consumption

An estimated 4,632 t of fish and crustaceans from both domestic fisheries and imports were consumed by households in 2003 (Dupont et al. 2004). Annual per capita consumption of fish and crustaceans was 21.6 kg.

Annual per capita consumption in early 2000 was estimated at 25.6 kg, 54.8 kg in rural areas and 10.7 kg in urban areas, based on Information from the HIES conducted in 1991, supplemented by independent analysis (Bell et al. 2009).

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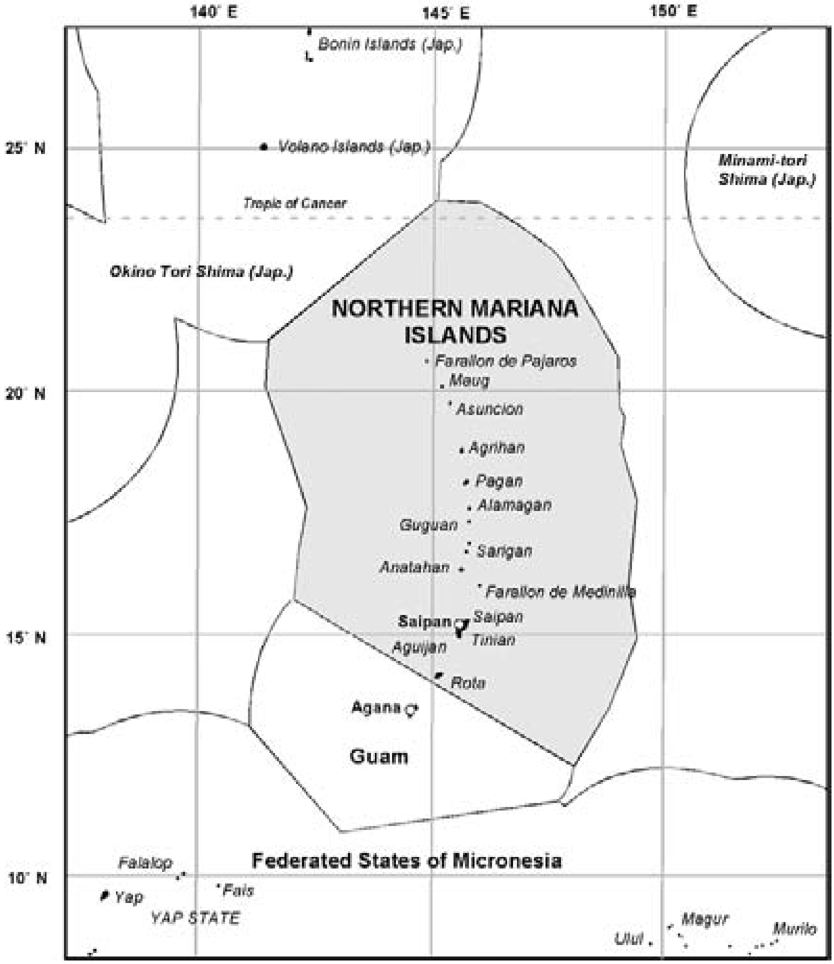
[51] Institut de la Statistique et des Etudes Economiques. Available: www.isee.nc

Northern Mariana Islands



Source: Secretariat of the Pacific Community.

Fish Production

Coastal Commercial Catches

Annual coastal commercial fishery production in the Commonwealth of the Northern Mariana Islands (CNMI) in 1994 was estimated at 141 t worth $613,804 by Dalzell et al. (1996), using information from the Western Pacific Fisheries Information Network (WPacFIN). WPacFIN provides access to best available fisheries data from the Western Pacific region.[52] The network monitors the commercial landings in CNMI. Quantities and values for 1982–2007 are available on the website. Table 20.1 gives these catches in recent years.

Table 20.1: Commercial Landings of CNMI

Year	Weight (million pound)	Weight (ton)	Value ($ million)
1990	0.440	199.5	0.735
1991	0.331	150.1	0.616
1992	0.382	173.2	0.753
1993	0.373	169.2	0.778
1994	0.398	180.5	0.878
1995	0.420	190.5	0.910
1996	0.518	234.9	1.132
1997	0.475	215.4	1.117
1998	0.523	237.2	1.264
1999	0.426	193.2	1.052
2000	0.434	196.8	1.003
2001	0.434	196.8	1.083
2002	0.490	222.2	1.132
2003	0.381	172.8	0.855
2004	0.367	166.4	0.821
2005	0.551	249.9	1.160
2006	0.537	243.5	1.059
2007	0.510	231.3	0.950

CNMI = Commonwealth of the Northern Mariana Islands.

Source: WPacFIN (2008).

52 According to website information (www.pifsc.noaa.gov/wpacfin)

Discussions with fisheries specialists in the CNMI indicate that all the 2007 catches should be considered nonindustrial in scale. Although two longliners began operating in 2007, they participated in several types of fishing, including bottom fishing, and their 2007 longline production was not very significant (R. Roberto, personal communication, October 2008).

It is estimated that the 2007 production from coastal commercial fishing in CNMI was 231 t worth $950,000 to the fishers.

Coastal Subsistence Catches

Subsistence production in early 1990s was estimated at 2,825 t worth $12.3 million (Dalzell et al. 1996).

Subsistence production in 1950 was estimated at 456 t by Zeller et al. (2007), based on a 1947 statement that "The native population of Saipan is somewhat in excess of 4,600 persons, and since they traditionally consume nearly a pound of fish per day, there is a steady market for fishery products" (Smith 1947). This statement of unknown accuracy and the associated estimate of 456 t in subsistence catches are keys in the Zeller et al. (2007) "data anchor point." This and other points were used to "reconstruct" coastal catch data for 1982–2002. Their catch estimate for noncommercial fisheries in 2002 was 106 t.

Many recent estimates of subsistence fisheries production[53] in the CNMI use the production of well-monitored commercial fisheries as basis for determining the noncommercial component:

- Commercial catches were multiplied by 1.7 to get total catches, by Radtke and Davis (1995).
- A commercial to subsistence ratio of 1:1 for 1993–2002 was used by Zeller et al. (2007).
- Commercial catches were multiplied by 1.3 to get total catches, by VanBeukering (2006).
- Commercial catches should be multiplied by a factor of 1.3 to get the total (commercial and subsistence) catches, according to staff of CNMI's Division of Fish and Wildlife (R. Roberto and M. Tenorio, personal communication, October 2008).

Based on 2007 production from coastal commercial fishing of 231 t, subsistence fisheries production is estimated to be 70 t.

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53 For the purpose of the present study, the catches from recreational fishing are considered as production for home consumption and, therefore, as a component of subsistence fisheries.

An alternative approach is to consider the various types of fisheries monitoring (none of which specifically focus on subsistence fisheries production) and adjust for subsistence components that are not covered and are aggregated with the commercial catch. A fisheries data expert with long historical involvement in monitoring CNMI fisheries adjusted the Saipan creel data, estimated the Saipan subsistence component in the total boat catch, and expanded these estimates to cover all the CNMI. This resulted in an estimate of 220 t for subsistence fishing in all of CNMI (D. Hamm, personal communication, December 2008).

A subsistence catch of 220 t is small compared to the Dalzell et al. (1996) estimate of 2,825 t. However, according to P. Dalzell (P. Dalzell, personal communication, December 2008), leakage of fish from the Zuanich tuna facility in CNMI could have been the source of the inflated subsistence fishery estimate.

Using the farm-gate system of valuing subsistence production (discounting commercial prices by 30%), it is estimated that a subsistence production of 220 t would be worth $631,700 to the fishers.

Locally Based Offshore Catches

Although two longliners began operating in 2007, they participated in several types of fishing, including bottom fishing, and their 2007 longline production was not very significant (R. Roberto, personal communication, October 2008). For the purpose of the present study, it is assumed that in 2007, there was virtually no locally based offshore fishing in CNMI.

Foreign-Based Offshore Catches

There is no authorized foreign fishing in CNMI zone.

Freshwater Catches

There are no freshwater fisheries in CNMI.

Aquaculture Harvests

The aquaculture specialist at the Cooperative Research Extension and Education Service of Northern Marianas College (M. Ogo, personal communication, October 2008) kindly provided the following information on recent aquaculture production in CNMI.

Shrimp culture (*Penaeus vannamei)* started in 2005. In 2007, production was about 24,000 pounds (10.9 t), with a farm-gate price of $8/pound ($17.60/kg)—a premium price for live/fresh shrimp to the large local tourist industry. Tilapia are also farmed, with production of about 500 pounds (227 kg)/month, which it is sold mainly at a farmers' market. The farm-gate price is about $2.20/pound ($4.84/kg).

Using the above information, 2007 aquaculture production in CNMI is taken to be 14 t, with a farm-gate price of $205,000.

Summary of Harvests

From the above sections, a crude approximation of the annual quantities and values of the fishery and aquaculture harvests in 2007 was made (Table 20.2).

The coastal commercial estimate above is judged to be accurate, relative to those in this study from other Pacific island countries and territories.

Contribution of Fishing to GDP

Current Official Contribution

The national accounts of CNMI are at a rudimentary stage of development. In 2004, the Office of Insular Affairs of the US Department of Interior awarded a contract to the US Census Bureau to produce estimates of GDP in CNMI.

Table 20.2: Annual Fisheries and Aquaculture Harvest in CNMI, 2007

Harvest Sector	Quantity (t)	Value[a] ($)
Coastal commercial	231	950,000
Coastal subsistence	220	631,700
Offshore locally based	0	0
Offshore foreign-based	0	0
Freshwater	0	0
Aquaculture	14	205,000
Total	**465**	**1,786,700**

CNMI = Commonwealth of the Northern Mariana Islands, t = ton.

[a] The values in the table are dockside/farm-gate prices.

Source: Consultant's estimates.

The primary source of information for making the estimates was the 2002 Economic Census (Rubin and Sawaya 2005b), which did not cover fishing (Census Bureau 2008).

The partial GDP for the industries covered in the 2002 census was $752.6 million–$966.9 million, and $895.0 million–$1,109.3 million when the value added from excluded sectors of agriculture [and fishing] and government was included (Rubin and Sawaya 2005b).

Method Used to Calculate the Official Fishing Contribution to GDP

As indicated above, fishing was not considered when making the GDP estimate for 2002.

Estimate of Fishing Contribution to GDP

Table 20.3 below presents an option for estimating fishing contribution to GDP in CNMI. It is a simple production approach that takes the values of the five types of fishing/aquaculture activities for which production values were determined and summarized in Table 20.2. This approach also determines the value added by using VARs characteristic of the type of fishing concerned. The VARs were determined by knowledge of the fisheries sector and by use of specialized studies (Appendix 3).

The contribution of fishing to GDP in 2007 estimated in Table 20.3 ($1.2 million) represented about 0.1% of the $1,002 million GDP estimate[54] for CNMI for 2002.

Zeller et al. (2007) estimated a fishing contribution (not including aquaculture) in 2002 of $1,022,000. Compared to the present study (which covered a period 5 years later), the Zeller estimate of the contribution from coastal commercial ($391,000) appears to be less and that from noncommercial ($631,000) to be greater.

Export of Fishery Products

There are no significant commercial exports of fishery products from CNMI.[55] Any fish sent overseas is largely for family and friends in Hawaii and mainland US.

[54] Midpoint of the $895.0 million to $1,109.3 million range in Rubin and Sawaya (2005b).

[55] A minor point is that there is trochus in CNMI and at least some is exported, e.g., 15 t in 1989 (Gillett 1995).

Table 20.3: Fishing Contribution to CNMI GDP in 2007

Harvest Sector	Gross Value of Production ($, from Table 20.2)	Value-Added Ratio	Value Added ($)
Coastal commercial	950,000	0.60	570,000
Coastal subsistence	631,700	0.80	505,360
Offshore locally based	0	0	0
Freshwater	0	0	0
Aquaculture	205,000	0.45	92,250
Total			**1,167,610**

CNMI = Commonwealth of the Northern Mariana Islands, GDP = gross domestic product.
Source: Author's estimates.

The large tourism industry induces substantial imports of seafood. In addition to canned fish, CNMI imports fresh fish from Palau, FSM, and Marshall Islands. Imports of reef fish into Saipan have been rapidly increasing, particularly since 1998 (VanBeukering 2006).

Government Revenue from Fisheries

Access Fees for Foreign Fishing

There is currently no authorized foreign fishing in the CNMI zone and no access fees are paid. US vessels are considered domestic vessels.

Other Government Revenue from Fisheries

Any fishing licensing fees paid by vessels based in CNMI go to US government agencies, not to the CNMI.

Employment

According to the 2000 census, there were 44,471 people in the labor force, of whom 42,753 were employed, with 614 of them in farming, fishing, and forestry (CNMI Department of Commerce website: www.commerce.gov.mp).

The 2005 HIES showed that 27,545 people were then in the labor force, of whom 24,449 were employed, with 894 of them in farming, fishing, and forestry.

In fisheries, the number of full-time, part-time, and charter boats increased each year in the 1990s. In 1999, there were over 700 registered vessels, of which 25% were engaged in full or part-time commercial fishing (Masga 2002). There were an estimated 68 "participants" in pelagic fishing in CNMI in 2004 (WPRFMC 2006).

Fishing is an important cultural activity in Saipan, more for pleasure than for consumption or sales. Of all the people surveyed in 2006, 20% were active fishers who went fishing once every week or two. For some people, giving fish to family and friends is a way of showing that they care; for others, it is a tradition (VanBeukering 2006).

The 2005 HIES showed that $888,776 was spent on production from domestic commercial fisheries. The imputed amount spent on domestic subsistence fisheries was not available from the HIES.

Fish Consumption

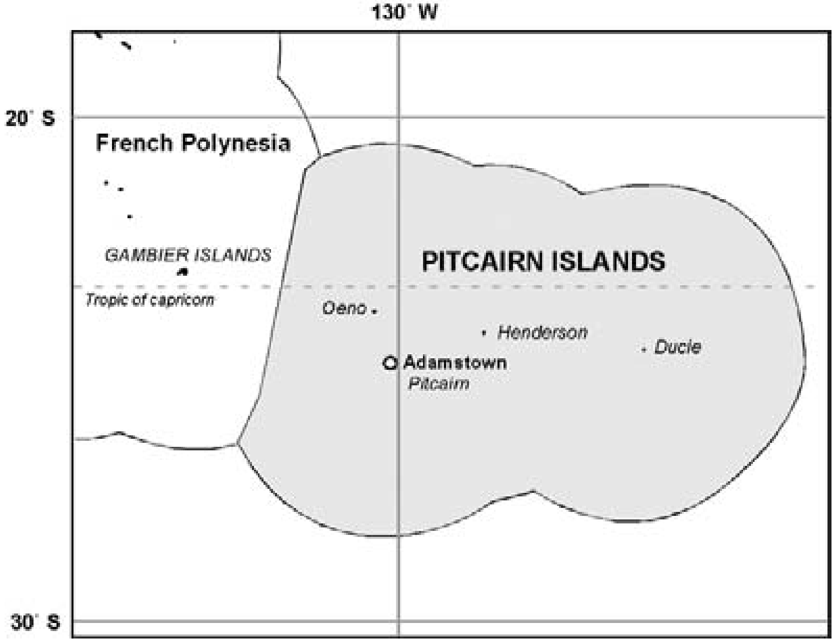
Annual per capita consumption was approximately 166 kg in late 1940s, according to Zeller et al. (2007) citing Smith (1947).

In early 1990s, production from coastal fisheries (commercial and subsistence) equated to an annual per capita fish supply of 66.5 kg (Gillett and Preston 1997). This figure was partially based on the Dalzell et al. (2006) estimate of 2,825 t per year from CNMI's subsistence fisheries, an amount that appears unreasonably large.

Unpublished HIES data (kindly provided by SPC's Statistics and Demography Programme) show that the amount of fish from domestic commercial fishing and canned imports equated to 4.7 kg per capita per year. This amount does not include the production from domestic subsistence fisheries nor non-canned imported fish.

It can be said that estimating the per capita fishery consumption for CNMI is complicated by the large amount of canned and non-canned seafood imports, the presence of a large tourist population, and a subsistence fishery that was not covered by the 2005 HIES or explicitly by current fishery monitoring programs.

Pitcairn Islands



Source: Secretariat of the Pacific Community.

Fish Production

Coastal Commercial Catches

Pitcairn Islands' annual commercial fisheries production was zero in early 1990s (Dalzell et al. 1996). However, the islanders do occasionally trade with passing ships (E. Dunn, personal communication, December 2008).

Sharples (1994) described the commercial transactions:

> "Trading in fish has thus become very important to the Islanders who actively seek opportunity to do so. Radios are monitored constantly for indication of ships in the vicinity and if heard a vessel is called and encouraged to stop to trade goods—fish, fruit, vegetables and, if a cruise vessel, carvings and other souvenir crafts. Goods are usually sold to cruise ships with fish generally fetching

> US$5.00/kilo regardless of species. Lobsters, when available, fetch closer to US$10.00. With the freighters that stop fish is usually bartered and the value received differs considerably from vessel to vessel. American vessels are popular because they will often swap kilo for kilo, fish for high quality meat. Asian vessels tend to swap dry goods. Pitcairners usually go aboard and bargain individually but may at times (particularly with cruise ships) have to lump their fish together then share out the proceeds (in their own special fashion) later."

No statistics are kept on these commercial fish transactions, but the implication in the statement by the Office of the Commissioner above is that the quantity is less than that from fishing for subsistence. Coastal commercial production may best be estimated by first focusing on subsistence fishing, for which there is at least some basis for making an estimate.

Coastal Subsistence Catches

Pitcairn's annual subsistence fisheries production was 8 tons (t) in early 1990s (Dalzell et al. 1996).

Sporadic information on fish catches is available from the island's newspaper, the Pitcairn Miscellany. The December 2005 issue included a "December 2005 Fishing Report by Lea" which stated[56] "Off rocks – 99; From boats – 189; Tuna – 52; Cuta – 2; Shark – 0." Reports are not always available; the April 2006 issue of the Pitcairn Miscellany states "no report this month, sorry."

Fishing is conducted on the narrow fringing reefs and reef slope around Pitcairn Islands, either from dinghies or from the rocky shore. Almost all fishing is conducted with hand-lines. There are several imported diesel-powered long boats and several small outboard-powered skiffs. Long boats and skiffs are occasionally used for trolling tuna and other coastal pelagic fish (Adams and Langley 2005).

Approximately 50 people have been resident on Pitcairn Islands in recent years. Fish is very important in the diet. Domestic fishing produces virtually all the fish consumed. Consumption is estimated at 140 kg per capita per year (whole fish equivalent), which is quite high and approximates that estimated for Kiribati and Tuvalu (Gillett and Lightfoot 2001). This consumption would equate to a subsistence catch of 7 t/year.

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56 These numbers are presumed to be fish numbers.

The catch taken for commercial purposes is less than this, but being "very important to the islanders" may be about 5 t.

The price for fish sold to ships and yachts reported by Sharples (1994) was $5/kg, regardless of species. No new price information is available, so a semi-arbitrary price of $7.50 (NZ$10.20)/kg was assigned. This price was discounted by 30% to value subsistence production. On this basis, in 2007, the commercial catch of 5 t was worth NZ$51,000 and the subsistence catch of 7 t was worth NZ$50,000.

Locally Based Offshore Catches

There is no locally based offshore fishing in Pitcairn Islands.

Foreign-Based Offshore Catches

Adams and Langley (2005) indicate that since 1990, longline fishing activity in the vicinity of the Pitcairn Islands zone has been dominated by the Taipei,China distant-water fleet. There has also been limited fishing activity by French Polynesia, Japan, Republic of Korea, and most recently, the People's Republic of China.

Information is only readily available on the first agreement allowing foreign-based offshore vessels and the latest agreement. The first agreement allowed up to 20 Japanese tuna longline vessels to fish in Pitcairn Islands waters in return for goods and services to the islanders and license fees based on a formula linking catches, species composition, and weighted species prices (Anon 1987). The latest agreement was in December 2006: a longliner of unspecified nationality was licensed to fish for a flat fee of $1,000 (D. Evans, personal communication, December 2008). Apparently there were just a few days of fishing.

Estimates of the quantities and values of catches of the four main commercial species of tuna in the WCPFC area for 1997–2007 were made by the Forum Fisheries Agency (FFA 2008), using data sourced from the Oceanic Fisheries Programme of the SPC. The only catch report in this data set for the Pitcairn Islands zone was 5 t of albacore worth NZ$16,086 in 2005 by a longline vessel. The information suggests that in 2007, there was no foreign-based offshore catch in the Pitcairn Islands zone.

Freshwater Catches

There are no freshwater fisheries in Pitcairn.

Aquaculture Harvests

There are no aquaculture activities in Pitcairn.

Summary of Harvests

From the above sections, a crude approximation of the annual quantities and values of the fishery harvests in 2007 was made (Table 21.1).

Table 21.1: Annual Fisheries and Aquaculture Harvest, Pitcairn, 2007

Harvest Sector	Quantity (t)	Value (NZ$)
Coastal commercial	5	51,000
Coastal subsistence	7	50,000
Offshore locally based	0	0
Offshore foreign-based	0	0
Freshwater	0	0
Aquaculture	0	0
Total	**12**	**101,000**

NZ$ = New Zealand dollar, t = ton.

Source: Consultant's estimates.

Contribution of Fishing to GDP

Current Official Contribution

Macroeconomic indicators such as gross domestic product (GDP) or gross national income (GNI) are not produced for the Pitcairn Islands.

Estimate of Fishing Contribution to GDP

Table 21.2 below presents an option for estimating the fishing contribution to GDP in Pitcairn Islands. It is a simple production approach that takes the values of the fishing activities for which production values were determined and summarized in Table 21.1. This approach also determines the value added by using VARs characteristic of the type of fishing concerned. The VARs were determined by knowledge of the fisheries sector and by use of specialized studies (Appendix 3).

Table 21.2: Fishing Contribution to the Pitcairn GDP, 2007

Harvest Sector	Gross Value of Production (NZ$, from Table 21.1)	Value-Added Ratio	Value Added (NZ$)
Coastal commercial	51,000	0.65	33,150
Coastal subsistence	50,000	0.95	47,500
Offshore locally based	0	0	0
Freshwater	0	0	0
Aquaculture	0	0	0
Total			**80,650**

GDP = gross domestic product, NZ$ = New Zealand dollar.

Source: Consultant's estimates.

Export of Fishery Products

The main exports of Pitcairn Islands are fruits, vegetables, curios, and stamps (CIA 2008). The fish sold to ships and yachts could also be considered export. They are sold to foreigners, usually purchased in foreign currency, and mostly consumed away from Pitcairn Islands. The value of these fishery exports equated to the value of the commercial catch, NZ$51,000.

Government Revenue from Fisheries

Access Fees for Foreign Fishing

There is currently no authorized foreign fishing in the Pitcairn Islands zone. The annual budget for Pitcairn is around NZ$9 million (Green 2008). If the December 2006 access fees were received in 2007, that money would have been 0.015% of the annual budget.

Other Government Revenue from Fisheries

Apart from fees for foreign fishing access, no information is available on government revenue from the fisheries sector.

Employment

Sharples (1994) provided details of fishing activities in the 1990s. There were 8 or 9 “hard-core fishers” on the island with another 3 or 4 who also fished fairly regularly. On any fine day that is not booked for some public duty or communal activity, 6 to 9 skiffs were out fishing, often with 1 or 2 fishers per skiff. Women and men fished regularly from the rocks, mainly for a fish locally called *nanwi,* for the evening meal.

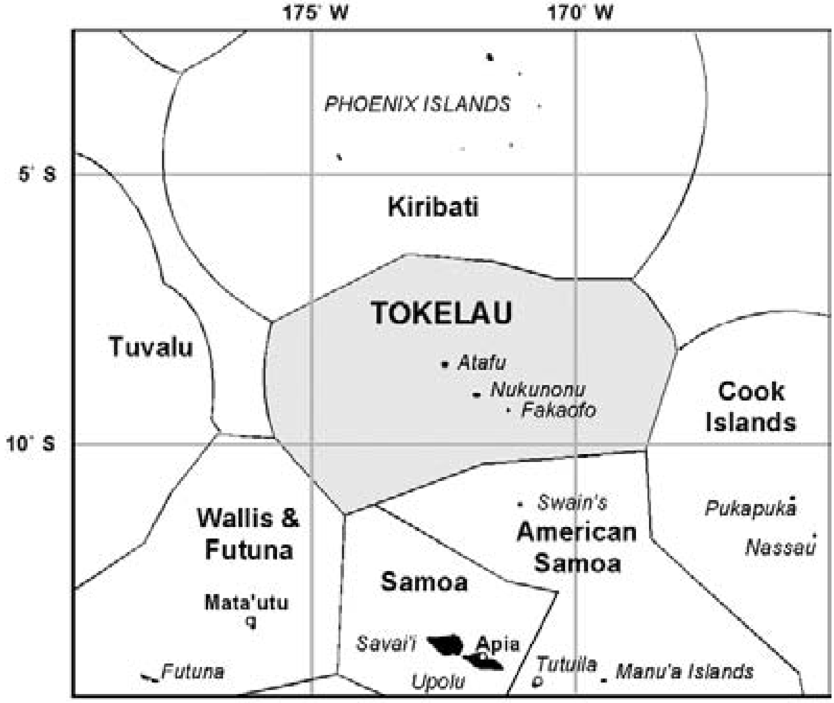
If a large vessel was expected (in particular, a cruise vessel), fishing effort increased. The hard-core would be out fishing from dawn to dusk. Any excuse to launch the long-boats (passing vessels being the best) was used to assemble a fishing crowd, which included some who did not fish much (Sharples 1994).

The Central Intelligence Agency (CIA 2008) reported on a matter that had implications for the involvement in fishing activities. In October 2004, more than one-quarter of Pitcairn Islands’ small labor force was arrested, putting the economy in a bind.

Fish Consumption

An annual per capita fish supply in early 1990s of 80 kg was estimated by Gillett and Preston (1997). That estimate, however, was erroneously based on a population of 100 people. The 1992 population of Pitcairn Islands was 54 (Pitcairn Islands Study Center 2008). Using the revised population, annual per capita fish supply would have been 148 kg.

Tokelau



Source: Secretariat of the Pacific Community.

Fish Production

Coastal Commercial Catches

Various reports (Dalzell et al. 1996; Passfield 1998; and the 2001 census [Anon 2003]) indicate that there is no commercial fisheries production in Tokelau. In view of this information, all coastal fishing in Tokelau is considered to be subsistence fishing.

Coastal Subsistence Catches

Annual Tokelau subsistence fishery production in early 1990s was estimated at 191 tons (t) worth $104,509, by Dalzell et al. (1996) based on Hooper (1984). Several estimates of coastal fisheries production have been made for Fakaofo Atoll. Some of these are shown below, with extrapolations to cover all three atolls, assuming that Fakaofo has one-third of the population.

- An annual total of 28 t of fish was required to satisfy the nutritional requirements of the 665 residents of Tokelau (Gulbrandsen 1977). Thus, 84 t would be needed for all of Tokelau.
- The weekly catch was about 1.5 t in 1981, according to a 5-week survey on Fakaofo by Hooper (1984). This would mean a total of 234 t annually for all of Tokelau.
- Gillett and Toloa (1987) monitored all fishery catches on Fakaofo for a 12-week period from June to September 1986 and estimated that 23 t of fish was landed (299 t for all of Tokelau).
- Total annual Fakaofo fishery production of 150 t, and 450 t for all of Tokelau, was estimated by Passfield (1998).

Due to increasing frequency of ship transport to Samoa (almost once every two weeks), fish are being sent more often from Tokelau to Samoa in recent years, mainly for family and friends, and for onward shipment to New Zealand (F. Toloa, personal communication, December 2008).

Fish is rarely sold in Tokelau. Consequently, placing a price on subsistence fishery production is difficult. Frozen chicken cannot be compared because it comes from New Zealand, a location that is two ocean voyages away and requires expensive freezing in Tokelau. Some fishery products from Tokelau are sold in Samoa, which is the nearest market. In 2007, market and roadside fish prices in Samoa were ST12.41/kg (NZ$6.44/kg) (Fisheries Division 2008d). Taking the 2007 Samoa commercial fish prices and discounting by 60% for fish preservation and transport from Tokelau to Samoa would indicate a price of NZ$2.58 for subsistence fish in Tokelau.

Passfield's estimate of 450 t catch for 1998, together with the probable level of recent exports (described below) and the recent decrease in Tokelau's population, suggests an annual per capita consumption for 2007 that appears improbably large.

It is estimated that the 2007 subsistence fishery production in Tokelau was 375 t worth NZ$967,500.

Locally Based Offshore Catches

There is no locally based offshore fishing in Tokelau.

Foreign-Based Offshore Catches

Fishing effort in Tokelau by foreign licensed vessels and licensing revenues has fluctuated substantially (Anon 2007d). No facilities exist in Tokelau for transshipping or processing large-scale commercial tuna catches. All catches are offloaded outside Tokelau.

Estimates of quantities and values of catches of the four main commercial species of tuna in the WCPFC area for 1997–2007 were made by the Forum Fisheries Agency (FFA 2008), using data sourced from the Oceanic Fisheries Programme of the Secretariat of the Pacific Community (SPC). In these data, prices are all "delivered" prices in that they reflect the price received at entry to the country in which they are usually sold whether for processing or consumption. Also, bycatch, which is an important component of offshore fisheries, is not included.

Catches by foreign vessels in the Tokelau zone are shown in Table 22.1. The total offshore catch consists of the longline tuna catch (plus 30% bycatch) and the purse seine tuna catch (plus 5% bycatch). Table 22.2 gives the value of the tuna catch in Table 22.1, adjusted for transport costs as noted in the table. The annual average catch for 2002–2006 was 2,630 t worth NZ$3,922,000. The 2007 catch does not appear to be typical for foreign-based offshore fishing.

Table 22.1: Foreign-Based Offshore Catches in the Tokelau Zone (t)

Item	2002	2003	2004	2005	2006	2007
Longline tuna catches	234	143	202	57	0	2
Purse seine tuna catches	6,722	25	983	5,088	121	300
Total offshore catch (longline and purse seine; tuna and bycatch)	7,362	212	1,295	5,417	1,177	318

t = ton.

Source: Forum Fisheries Agency (2008) and consultant's estimates.

Table 22.2: Value of Foreign-Based Offshore Catches in the Tokelau Zone

Item	2002	2003	2004	2005	2006	2007
Value of longline catch ($)	547,811	431,118	730,301	225,756	1,931	14,708
Value of purse seine catch ($)	5,292,359	25,079	917,987	4,475,199	1,098,586	403,623
Value of total tuna catch ($)	5,840,170	456,197	1,648,288	4,700,955	1,100,517	418,331
Adjusted value of tuna catch ($)[a]	5,548,161	433,388	1,565,873	4,465,907	1,045,492	397,415
Adjusted value of tuna catch (NZ$)[a]	11,928,546	745,427	2,364,469	6,341,588	1,610,057	540,484

NZ$ = New Zealand dollar.

[a] Values have been reduced by 5% for transport to the major market, Pago Pago.

Source: Forum Fisheries Agency (2008) and consultant's estimates.

Freshwater Catches

There is no freshwater fishery in Tokelau.

Aquaculture Harvests

There is no aquaculture activity in Tokelau.

Summary of Harvests

From the above sections, a crude approximation of the annual quantities and values of the fishery harvests in 2007 was made (Table 22.3).

Contribution of Fishing to GDP

Current Official Contribution

Macroeconomic indicators, such as gross domestic product (GDP) or gross national income (GNI), are not produced, according to the financial adviser to the Government of Tokelau (A. Shaw, personal communication, October 2008).

Table 22.3: Annual Fisheries and Aquaculture Harvest, Tokelau, 2007

Harvest Sector	Quantity (t)	Value (NZ$)
Coastal commercial	0	0
Coastal subsistence	375	967,500
Offshore locally based	0	0
Offshore foreign-based	318	540,484
Freshwater	0	0
Aquaculture	0	0
Total	**693**	**1,701,484**

NZ$ = New Zealand dollar, t = ton.

Source: Tables 22.1 and 22.2.

Estimate of Fishing Contribution to GDP

Table 22.4 presents an option for estimating fishing contribution to GDP in Tokelau. It is a simple production approach that takes the values of the fishing/aquaculture activities for which production values were determined and summarized in Table 22.3. This approach determines the value added by using VARs characteristic of the type of fishing concerned. The VARs were determined by knowledge of the fisheries sector and by use of specialized studies (Appendix 3).

Table 22.4: Fishing Contribution to Tokelau GDP, 2007

Harvest Sector	Gross Value of Production (NZ$, from Table 22.3)	Value-Added Ratio	Value Added (NZ$)
Coastal commercial	0	0	0
Coastal subsistence	967,500	0.75	725,625
Offshore locally based	0	0	0
Freshwater	0	0	0
Aquaculture	0	0	0
Total			**725,625**

NZ$ = New Zealand dollar.

Source: Consultant's estimates.

Export of Fishery Products

Tokelau exports are not monitored (A. Shaw, personal communication, October 2008). Most people have freezers and send seafood to friends and relatives abroad. A 1998 survey showed that some people send seafood out on every boat (i.e., approximately monthly), while others send seafood only once or twice per year. Exports on the trip leaving Fakaofo on 5 August 1998 were approximately 450 kg, which can be extrapolated to 5.4 t for Fakaofo for the year (Passfield 1998). The major exports were flyingfish and giant clams (frozen and dried). Dried fish are also exported.

Recently, transport between Samoa and Tokelau has improved considerably. In 2008, there was a trip nearly every 2–3 weeks. The on-board freezer, with a capacity of about 6 t of fish, is often full with fishery products (F. Toloa, personal communication, December 2008). This could equate to around 125 t of fishery exports from Tokelau annually.

Government Revenue from Fisheries

Access Fees for Foreign Fishing

Offshore fishing in Tokelau waters is undertaken by foreign fishing vessels of distant-water fishing nations and neighboring Pacific island states (Anon 2007d). Vessels licensed in recent years include New Zealand and US purse seiners, and a few Vanuatu longliners. The amount of money received for this fishing (referred to by the Government of Tokelau as "EEZ fees") is given in Table 22.5.

For the 2007/08 financial year, the Tokelau recurrent budget was about NZ$17 million (MFAT 2008). Besides EEZ fees, the only source of local revenue for the government is "local licensing" and "stamps and coins," which together amounted to NZ$54,000 in 2006 and NZ$98,000 in 2007 (Government of Tokelau, unpublished data). Fishing access fees amounted to 85% of the government's local revenue in 2006 and 95% in 2007.

Average annual catch of the foreign-based offshore vessels in Tokelau waters for 2002–2006 was 2,630 t worth NZ$3,922,000 (see section 22.1). Average annual amount for licensing fees for the same period from Table 22.5 above was NZ$1,102,833. Access fees, therefore, represented 28% of the value of catch. This is very high compared to other countries in the region.

Table 22.5: Fishing Access Fees Received by Tokelau

Year	Amount (NZ$'000)
2001	1,597
2002	1,545
2003	1,900
2004	289
2005	569
2006	303
2007	2,011
2008	1,181

NZ$ = New Zealand dollar.

Source: Tokelau Government, unpublished data.

Total revenue from the EEZ seems low. In Tuvalu, the purse seine fishing conditions are somewhat better and the zone is larger, but Tokelau's zone is located closer to the canneries in Pago Pago (for fleets that so dispose of their catch). Tuvalu's total fishing access fees were about NZ$26 million in 2002–2006, over five times those of Tokelau.

Appendix 4, on the effects of climate change on fisheries, suggests that expected changes could have a positive effect on skipjack purse seine fishing and associated access fees in the Tokelau EEZ.

Other Government Revenue from Fisheries

Apart from fees for foreign fishing access, no information is available on other forms of government revenue from the fisheries sector, such as fish export taxes or fishing registration fees. There is no mention of such revenue in any of the documents on Tokelau fisheries.

Employment

An SPC-FFA survey to gather information for drafting a national tuna fishery development and management plan was carried out in August and September 2003 (Chapman et al. 2003). Data on household participation in fishing are given in Table 22.6.

Table 22.6: Tokelau Household Participation in Fishing, 2003

Atoll	Number of Households Surveyed	Number of People Covered	People per Household	Households that Fish	Fishing Households Share of Total (%)
Atafu	46	299	6.5	46	100.0
Fakaofo	58	320	5.5	57	98.3
Nukunonu	49	280	5.7	49	100.0
Total	**153**	**899**	**5.9**	**152**	**99.3**

Source: Chapman et al. (2003).

Table 22.6 shows that virtually all Tokelauans depended on harvesting marine products. Males were the main household members involved in fishing activities. Few females took part in fishing outside the reef. Women at Nukunonu were not involved in fishing outside the reef at all. Females accounted for just over half the reef gleaning effort, and around 40% of diving effort, with most of the diving effort directed at harvesting clams (Chapman et al. 2003).

Time spent on fishing is considerable. In 1998, the average household spent 14 person hours/week fishing, with women spending an average of 2 hours, and men 12 hours. In 90% of households interviewed, men spent some time fishing every week. In 60% of households, women also spent some time fishing (Passfield 1998).

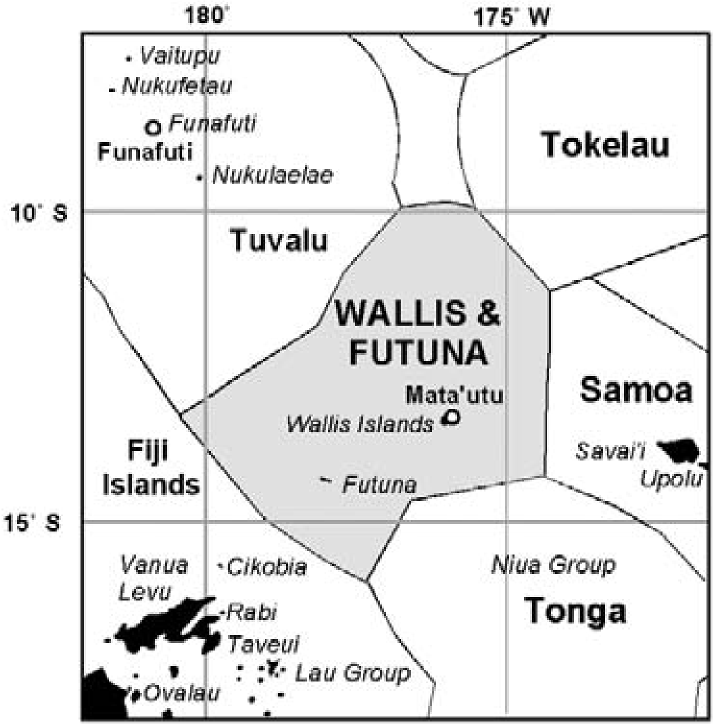
Fish Consumption

Production from coastal fisheries in Tokelau in early 1990s equated to an annual per capita fish supply of 119.4 kg (Gillett and Preston 1997).

In 1998, estimated consumption on Fakaofo equated to 248 kg per capita per year, whole fish equivalent, or a total consumption of around 140 t/year. An average of 380 grams of seafood was eaten on average 12.6 times per week, or at 73% of all meals consisting of some animal protein content (Passfield 1998).

The information in the present study—375 t coastal production, 125 t annual exports, and a population in 2007 of 1,170—indicates a consumption of 214 kg per person per year, which is quite large.

Wallis and Futuna



Source: Secretariat of the Pacific Community.

Fish Production

Coastal Commercial Catches

Coastal commercial production was estimated at 296 tons (t) worth $2,316,729, by Dalzell et al. (1996), based on 1994 data and discussions with a fisheries officer. This estimate became institutionalized. From 1998 to 2005, the entire marine fish catch of Wallis and Futuna in the Food and Agriculture Organization of the United Nations (FAO) statistics was 296 t. In 2006, the marine fish catch in the FAO statistics jumped to 596 t (FAO 2008).

A detailed inventory of the fishers, fishing gear, and fishing practices of Wallis and Futuna was undertaken in 2001 (Fourmy 2002), but no catch estimates were made.

A household income and expenditure survey (HIES) carried out between June 2005 and May 2006 (Buffiere 2006) showed that 104 t of fishery products were purchased, and 734 t of fresh fish and an unknown amount of "other seafood" were caught during the year. The prices/kg used in the HIES were CFP900 for fresh fish and CFP1,200 for other seafood.

To use the above information to make an estimate of the fisheries production of Wallis and Futuna, certain considerations and assumptions were required, some of which had a weak factual basis. It was assumed that for estimating fish production, the recent HIES was more accurate and relevant than data derived from a discussion with a fisheries officer 14 years ago and a review of the economy covering an annual period 15 years ago. It was also assumed that the amount of "other seafood" for subsistence purposes was five times that of "other seafood" that is sold. Finally, subsistence production was valued using the "farm-gate" system of valuing subsistence production, discounting commercial prices by 30%.

Using the above information, it is estimated that the annual coastal commercial catch for domestic consumption in the mid-2000s was 104 t valued at CFP100 million.

To the above coastal commercial fisheries production for domestic consumption, fishery exports must be added. The exports are exclusively trochus and bêche de mer, although no bêche de mer have been exported since 2005. Trochus exports were 29.2 t in 2006, with a free on board (FOB) value of CFP11.4 million; and 17.0 t in 2007, with an FOB value of CFP6.8 million (unpublished data from Service Territorial de la Statistique et des Etudes Economique, courtesy E. Valefakaaga). Reducing the FOB export values to approximate prices paid to fishers, the 17 t of fishery exports in 2007 is estimated to be worth CFP4.8 million.

It is estimated that in 2007, total production from coastal commercial fisheries was 121 t valued at CFP105 million.

Coastal Subsistence Catches

Coastal subsistence production in 1994 was estimated at 621 t worth $3,105,360 (Dalzell et al. 1996). Based on the above approach, however, the annual coastal subsistence catch in the mid-2000s is estimated to be 840 t worth CFP551 million.

Total coastal fishery production (commercial and subsistence) is, therefore, 961 t, about 5% greater than the Dalzell et al. (1996) estimate. This does not seem inconsistent, considering that the population of Wallis and Futuna increased 8% between the period covered by the Dalzell estimate and 2007 (SPC 2008a).

Locally Based Offshore Catches

Although there is some trolling outside the reef for tuna and other pelagic fish, this is considered to be coastal fishing for the purpose of the present study. There is no locally based offshore fishing fleet.

Foreign-Based Offshore Catches

There is currently no authorized foreign fishing in the Wallis and Futuna zone. The last foreign fishing activity occurred in 1999 (Service de la Pêche et de l'Aquaculture 2007).

Freshwater Catches

There is no freshwater fishery in Wallis and Futuna. Tilapia have been introduced into freshwater bodies on Wallis (Hinds 1969), but it is not considered a food fish.

Aquaculture Production

Although there have been some recent aquaculture trials on Wallis of the freshwater shrimp *Macrobrachium* (Nandlal 2005a), there is currently no aquaculture production in the territory.

Summary of Harvests

A crude approximation of the annual volumes and values[57] of fisheries production in 2007 is given in Table 23.1.

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57 Values at first sale or at the farm gate.

Table 23.1: Annual Fisheries and Aquaculture Harvest, Wallis and Futuna, 2007

Harvest Sector	Quantity (t)	Value (CFP)[a]
Coastal commercial	121	105,000,000
Coastal subsistence	840	551,000,000
Offshore locally based	0	0
Offshore foreign-based	0	0
Freshwater	0	0
Aquaculture	0	0
Total	**961**	**656,000,000**

CFP = Pacific franc, t = ton.

[a] These are values at first sale or at the farm gate.

Source: Consultant's estimates.

Contribution of Fishing to GDP

Current Official Contribution

Information on the national accounts of Wallis and Futuna is not readily available. Staff of the Service Territorial de la Statistique et des Études Économique are not involved in national accounts work (E. Valefakaaga, personal communication, November 2008). The GDP was CFP18 billion in 2005. No information is available on the contribution of fishing to GDP (Simon 2008).

Method Used to Calculate Official Fishing Contribution to GDP

Information on the method used to calculate the contribution of fishing to GDP (if there is such a method) is not available.

Estimate of Fishing Contribution to GDP

Table 23.2 below presents an option for estimating fishing contribution to GDP in Wallis and Futuna. It is a simple production approach that takes the values of fishing activities for which production values were determined and summarized in Table 23.1. This approach also determines the value added by using VARs characteristic of the type of fishing concerned. The VARs were determined by knowledge of the fisheries sector and by use of specialized studies (Appendix 3). The contribution of fishing (CFP509 million) to GDP in 2007 represents 2.8% of the GDP of Wallis and Futuna for 2005 given by Simon (2008).

Export of Fishery Products

Unpublished export data from Service Territorial de la Statistique et des Etudes Economique was used to construct Table 23.3.

Staff of the Service Territorial de la Statistique et des Études Économique confirmed that the only officially documented export of Wallis and Futuna in 2007 was trochus (E. Valefakaaga, personal communication, November 2008).

Table 23.2: Fishing Contribution to Wallis and Futuna GDP, 2007

Harvest Sector	Gross Value of Production (CFP, from Table 23.1)	Value-Added Ratio	Value Added (CFP)
Coastal commercial	105,000,000	0.65	68,250,000
Coastal subsistence	551,000,000	0.80	440,800,000
Offshore locally based	0	0	0
Freshwater	0	0	0
Aquaculture	0	0	0
Total			**509,050,000**

CFP = Pacific franc.

Source: Consultant's estimates.

Table 23.3: Fishery Exports, Wallis and Futuna

Item		2001	2002	2003	2004	2005	2006	2007
Bêche de mer	Weight (kg)	396	0	261.5	312	497	0	0
	Value (CFP)	838,800	0	794,500	624,000	1,545,900	0	0
Trochus	Weight (kg)	102,000	154,000	59,100	15,200	29,750	29,200	17,000
	Value (CFP)	31,005,500	45,470,000	19,590,000	4,560,000	11,839,000	11,370,280	6,800,000

CFP = Pacific franc, kg = kilogram.

Source: Unpublished data from Service Territorial de la Statistique et des Etudes Economique.

Government Revenue from Fisheries

Access Fees for Foreign Fishing

Since 1999, there have not been any access agreements with foreign fishing fleets (Service de la Pêche et de l'Aquaculture 2007). Consequently, no access fees for foreign fishing have been received since that time.

Other Government Revenue from Fisheries

Information is not readily available on other forms of government revenue from the fisheries sector.

Employment

A survey in 2001 of fishers—defined as persons who fish at least once a week—identified 333 fishers on Wallis, 26% of whom fished only once a week, 54% twice a week, and 20% three or more times a week; and 46 fishers on Futuna, only 10 of whom fished often enough to be considered an "artisanal fisher" (Fourmy 2002).

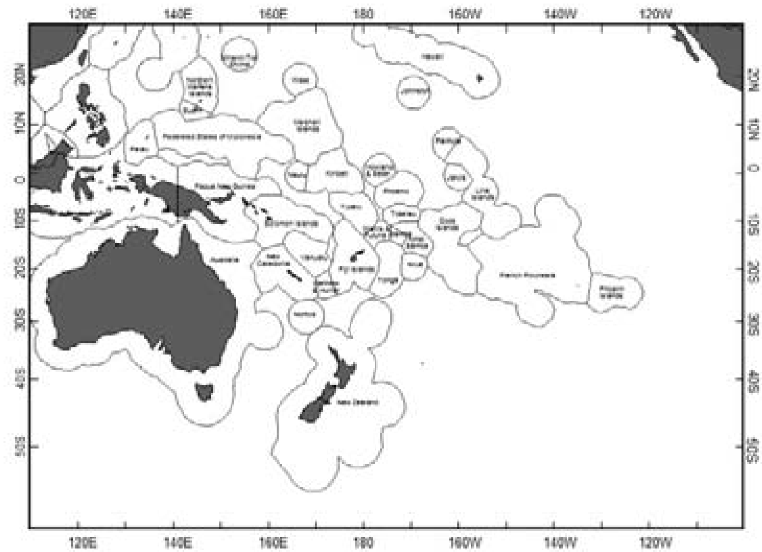
On Futuna, men go fishing, but it is mainly the women who provide the daily seafood. The island of Wallis is relatively flat compared to Futuna and gardens do not have to be made in difficult terrain so far away from the villages. The women of Wallis are not involved in fishing in the same way as the Futunan women (SPC 1999).

To put the number of fishers in perspective, of the 9,400 people 15–60 years of age in Wallis and Futuna (SPC 2008a), only 3,104 (33%) are formally employed (www.wallis.co.nc/stats). Unemployment is the territory's most pressing economic and social problem (Anon 2007e).

Fish Consumption

Annual per capita fish supply in early 1990s was estimated at 66.9 kg (Gillett and Preston 1997), and in 2005 and 2006 an average of 74.6 kg, of which 98% was fresh fish (Bell et al. 2009, based on 2005/2006 HIES data).

International Waters



Source: Secretariat of the Pacific Community.

Fish Production in International Waters

Seven bodies of international water are recognized in the SPC/FFA statistics (P. Williams, personal communication, December 2008), as follows:

1. Doughnut hole between Papua New Guinea and Federated States of Micronesia (FSM).
2. Doughnut hole between FSM, Solomon Islands, Kiribati, Marshall Islands, Nauru, and Tuvalu.
3. International waters east of the Philippines to Guam, above FSM, around the Marshall Islands, up to 20°N, and west of 175°E (not including areas 1 and 2 above).
4. International waters between Tuvalu, Phoenix, and Tokelau, up to 20°N, and east of 175°E to 170°W.
5. International waters between Phoenix and Line Groups, up to 20°N, east of 170°W to 130°W (includes waters between the Cook Islands and French Polynesia).

6. Remainder of international waters not covered above in the northern hemisphere of the area of the Western and Central Pacific Fisheries Commission (WCPFC).
7. Remainder of international waters not covered above in the southern hemisphere of the area of the WCPFC.

Estimates of the quantities and values of catches of the four main commercial species of tuna in the WCPFC area for 1997–2007 were made by the Forum Fisheries Agency (FFA 2008), using data sourced from the Oceanic Fisheries Programme of the Secretariat of the Pacific Community. In these data, prices are all "delivered" prices in that they reflect the price received at entry to the country in which they are usually sold whether for processing or consumption. Also, bycatch, which is an important component of offshore longline fisheries, is not included.

Estimates of the catches in international waters and their values are given in Table 24.1. The figures presented have been modified from FFA (2008) to reflect bycatch and the "in-zone" value as noted in the table.

Over the 6 years covered in Table 24.1, catches in the seven bodies of international water were equal to about half (range 38%–59%) of all in-zone catches of the 22 countries and territories of the Pacific islands.

Table 24.1: Catches in International Waters, 2002–2007

	2002	2003	2004	2005	2006	2007
Quantity (t)						
Longline[a]	162,165	135,036	137,940	122,438	97,739	90,133
Purse seine[b]	302,499	271,736	314,028	322,626	243,106	325,542
Pole-and-line	84,362	113,441	100,492	121,255	115,910	122,201
Troll	1,916	2,787	1,827	1,071	1,070	599
Other gear	332	126	61	154	221	221
Total	**551,273**	**523,126**	**554,348**	**567,544**	**458,045**	**538,696**
Value ($)[c]						
Longline	446,462,620	373,439,812	434,233,089	370,694,325	334,879,887	326,290,730
Purse seine	218,096,283	180,210,040	251,634,242	259,650,679	209,807,524	371,684,271
Pole-and-line	105,929,967	134,457,442	132,915,253	137,025,281	196,145,020	194,311,012
Troll	3,086,420	4,725,095	3,572,489	2,349,828	2,574,651	1,050,167
Other gear	534,808	213,621	119,279	337,884	531,774	387,457
Total	**774,110,098**	**693,046,011**	**822,474,351**	**770,057,996**	**743,938,856**	**893,723,637**

t = ton.

[a] Longline tuna catches have been increased by 30% to reflect bycatch.
[b] Purse seine tuna catches have been increased by 5% to reflect bycatch.
[c] All values were decreased by 10% to cover the cost of transport to markets.

Source: Forum Fisheries Agency (2008) and consultant's estimates.

The total 2007 catch taken in international waters equated to about 21% of the catch taken in the entire Western and Central Pacific Ocean (WCPO) (including the WCPO catch of Indonesia, Japan, Philippines, and Taipei,China).

In 2007, 17% of the total catch in international waters and 37% of the total value were made by longliners; 60% and 42%, by purse seiners, respectively; and 23% and 22% by pole-and-line vessels, respectively.

In the same year, longliners caught only 10% of the entire WCPFC area catch; purse seiners caught 71%; and pole-and-line vessels, 9%. This suggests that longliners and pole-and-line vessels fish proportionally more in international waters than in-zone, while longliners and purse seiners fish proportionally less.

The last statement refers to the average of all international waters in the region, and combines areas in the northern and southern parts of the region (where there is little or no purse seining) with the two “doughnut holes” of international waters, where there is substantial purse seining.

Only about 10% of tuna catch in international waters was made by vessels registered in Pacific island countries in 2007. The major participating Pacific island countries were PNG (23,035 t), Vanuatu (19,020 t), and the Marshall Islands (9,948 t) (unpublished data from SPC; P. Williams, personal communication, January 2009).

PART D

Regional Fisheries Production, Benefits, and Factors Influencing Benefits

Fisheries and Aquaculture Production Across the Region

Summary Information

Information on the quantities and values of fisheries production for each country is given in the country chapters of this report. Summary information is given in Tables 25.1 and 25.2 below. The values in Table 25.2 reflect prices paid to the producer—either dockside prices, prices at first sale, or (for aquaculture and subsistence fishing) farm-gate prices. For offshore fishing, an analogous system is used in which the readily available world market prices for the concerned fishery commodities are discounted by an amount to cover transport of the commodities to those markets.

Table 25.1: Pacific Islands Fisheries Production, 2007

Country	Coastal Commercial	Coastal Subsistence	Offshore Locally Based	Offshore Foreign-Based	Freshwater	Total	Aquaculture	
							t	Pieces
Papua New Guinea	5,700	30,000	256,397	327,471	17,500	637,068	200	0
Kiribati	7,000	13,700	0	163,215	0	183,915	143	100
Federated States of Micronesia	2,800	9,800	16,222	143,315	1	172,138	0	16,000
Solomon Islands	3,250	15,000	23,619	98,023	2,000	141,892	165	8,202
Marshall Islands	950	2,800	63,569	12,727	0	80,046	0	25,000
Nauru	200	450	0	69,236	0	69,886	8	0
Fiji Islands	9,500	17,400	13,744	492	4,146	45,282	247	48,100
Tuvalu	226	989	0	35,541	0	36,756	0	0
Vanuatu	538	2,830	0	12,858	80	16,306	34	2,500
French Polynesia	4,002	2,880	6,308	0	100	13,290	56	0
Samoa	4,129	4,495	3,755	25	10	12,414	10	0
Tonga	3,700	2,800	1,119	0	1	7,620	0	12,334
New Caledonia	1,350	3,500	2,122	0	10	6,982	1,931	0
American Samoa	35	120	6,632	0	1	6,788	9	0
Palau	865	1,250	3,030	1,464	1	6,610	2	3,100
Cook Islands	133	267	3,939	0	5	4,344	3	190,000
Wallis and Futuna	121	840	0	0	0	961	0	0
Niue	10	140	640	0	0	790	0	0
Tokelau	0	375	0	318	0	693	0	0
Northern Mariana Islands	231	220	0	0	0	451	14	0
Guam	44	70	0	0	3	117	162	0
Pitcairn Islands	5	7	0	0	0	12	0	0
Total	**44,789**	**109,933**	**401,096**	**864,685**	**23,858**	(see Table 25.3)	**2,984**	**305,336**

t = ton.

Source: Country chapters of this report.

Table 25.2: Value of Pacific Islands Fisheries and Aquaculture Production, 2007 ($)

Country	Coastal Commercial	Coastal Subsistence	Offshore Locally Based	Offshore Foreign-Based	Freshwater	Aquaculture	Total
Papua New Guinea	27,027,027	35,472,973	345,976,228	386,361,944	16,554,054	675,676	812,067,902
Kiribati	18,487,395	28,571,429	0	197,051,374	0	75,630	244,185,828
Federated States of Micronesia	7,560,000	15,732,000	23,908,377	177,195,590	8,000	80,000	224,483,967
Solomon Islands	3,307,190	10,980,392	32,662,077	153,548,868	1,464,052	40,654	202,003,233
French Polynesia	23,004,598	13,208,276	28,247,299	0	488,506	123,708,046	188,656,724
Marshall Islands	2,900,000	4,312,000	81,210,390	19,572,712	0	130,000	108,125,102
Fiji Islands	33,750,000	33,812,500	29,293,750	527,500	4,287,500	1,749,375	103,420,625
Nauru	840,336	661,345	0	80,001,361	0	15,126	81,518,168
New Caledonia	8,689,655	15,770,115	8,563,218	0	45,885	16,594,253	49,663,126
Tuvalu	616,526	2,232,686	0	40,924,370	0	0	43,773,582
Samoa	19,557,592	14,903,842	8,362,836	49,300	33,206	33,206	42,939,982
Vanuatu	2,176,923	5,740,385	0	26,003,657	173,077	303,846	34,397,887
Palau	2,843,000	2,511,000	13,779,656	4,947,496	8,000	50,000	24,139,152
Tonga	11,287,129	6,182,178	3,081,498	0	1,980	18,317	20,571,101
American Samoa	166,000	478,000	14,135,083	0	4,000	10,000	14,793,083
Cook Islands	1,029,412	1,250,000	5,772,059	0	36,765	2,235,294	10,323,529
Wallis and Futuna	1,206,897	6,333,333	0	0	0	0	7,540,230
Niue	58,824	617,647	1,844,118	0	0	0	2,520,588
Northern Mariana Islands	950,000	631,700	0	0	0	205,000	1,786,700
Guam	195,000	217,000	0	0	10,000	948,000	1,370,000
Tokelau	0	711,397	0	397,415	0	0	1,108,812
Pitcairn Islands	37,500	36,765	0	0	0	0	74,265
Total	**165,691,002**	**200,366,961**	**596,836,589**	**1,086,581,587**	**23,115,025**	**146,872,423**	(see Table 25.4)

Source: Country chapters of this report.

Table 25.3: Total Regional Fishery Production, 2007 (t)

Item	Coastal Commercial	Coastal Subsistence	Offshore		Freshwater	Regional Total
			Offshore Locally Based	Offshore Foreign-Based		
Fishery category totals	44,789	109,933	401,096	864,685	23,858	
Totals adjusted for duplicate offshore fishing	44,789	109,933	1,148,781		23,858	1,327,361

t = ton.

Note: Table does not include aquaculture due to difference in units (weights and pieces).

Source: Table 25.1 and Secretariat of the Pacific Community unpublished data.

Table 25.4: Value of Total Regional Fishery and Aquaculture Production, 2007 ($)

Item	Coastal Commercial	Coastal Subsistence	Offshore		Fresh-water	Aqua-culture	Regional Total
			Offshore Locally Based	Offshore Foreign-Based			
Fishery category totals	165,691,002	200,366,961	596,836,589	1,086,581,587	23,115,025	146,872,423	
Totals adjusted for duplicate offshore fishing	165,691,002	200,366,961	1,513,418,176		23,115,025	146,872,423	2,049,463,587

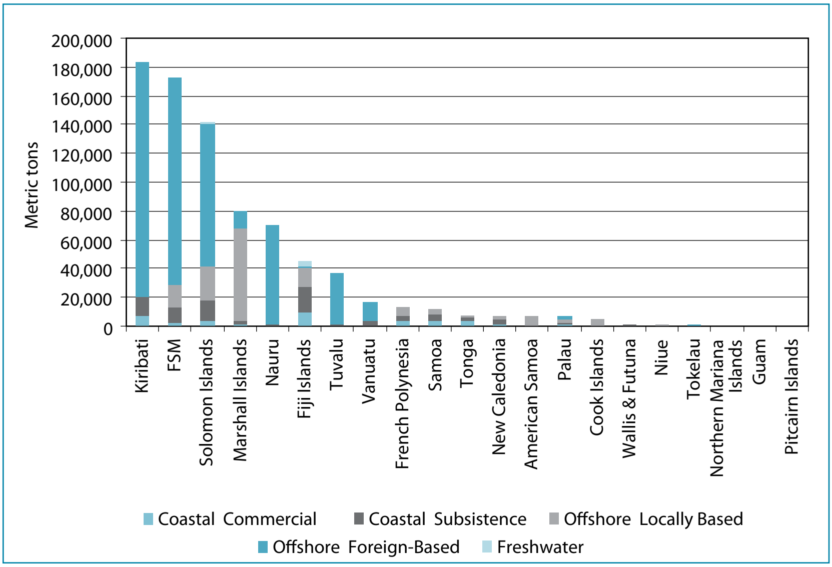
Note: Table includes aquaculture.

Source: Table 25.2 and Secretariat of the Pacific Community unpublished data.

To compile the regional total of the five categories, some adjustments had to be made. "Offshore foreign-based" is by geographic zone, while "offshore locally based" is by fleet. Double counting can occur because the catch of a Pacific island fleet in the zone of another Pacific island country is counted both as "offshore locally based" in the home country of the fleet and as "offshore foreign-based" in the country where the catch is made. Unpublished data from the Secretariat of the Pacific Community (SPC) (P. Williams, personal communication, January 2009) show that in 2007, fleets from Pacific island countries made tuna catches of 117,000 t (94% by purse seine gear) worth about $170 million, in the zones of other Pacific island countries. These amounts are subtracted in Tables 25.3 and 25.4 from totals when combining the categories of "offshore locally based" and "offshore foreign-based" across the region.

Composition of the aggregate national fisheries production in each country is quite different across the region. Figures 25.1 and 25.2 show the relative catches and values by component for each country, except for Papua New Guinea (PNG). The total production of PNG (637,068 t) overshadows that of all the other countries of the region. Including PNG in the figures would obscure the composition details of most other countries. The relative composition of PNG's fishery production is shown by pie chart in the PNG country chapter (Chapter 10).

Figure: 25.1: Fishery Production, 2007 (t)

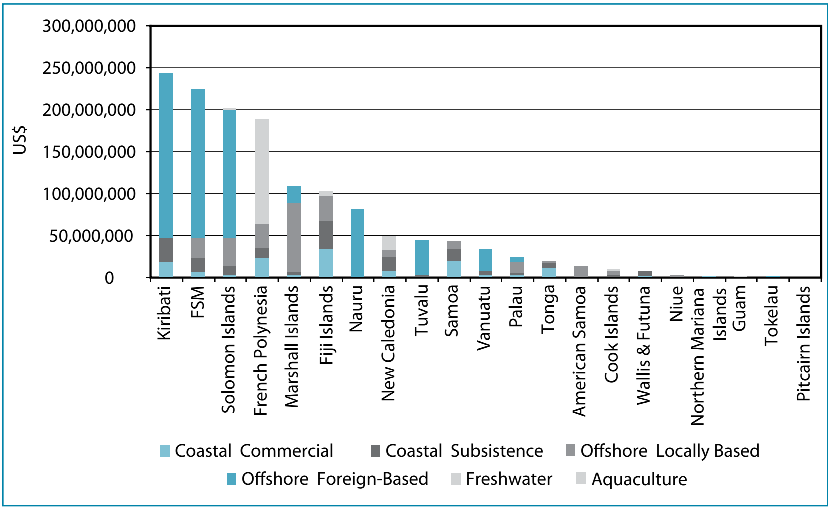


FSM = Federated States of Micronesia, t = ton.

Note: PNG excluded. Figure does not include aquaculture due to difference in units (weights and pieces).

Source: Table 25.3.

Figure 25.2: Values of Fisheries and Aquaculture Production, 2007 ($)



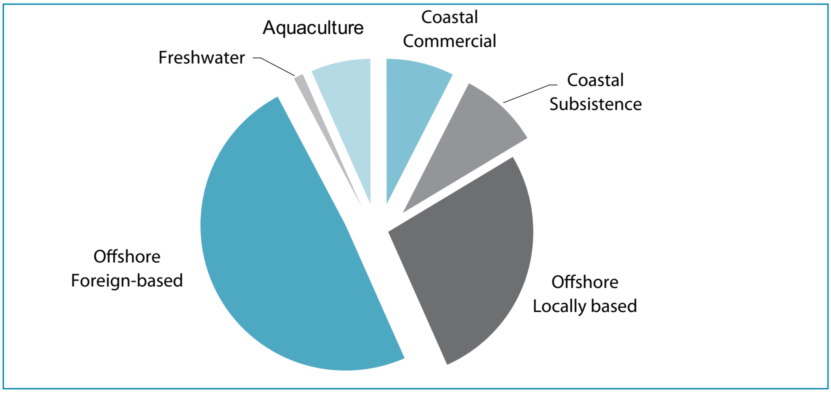
FSM = Federated States of Micronesia.

Note: PNG excluded. Figure includes aquaculture.

Source: Table 25.4.

The share of each fishery category in the value of overall regional production (including PNG) from fisheries and aquaculture is given in Figure 25.3. Offshore foreign-based fishing is responsible for about half the total value of fisheries in the region; offshore locally based for about a quarter; and coastal commercial, coastal subsistence, and aquaculture for the remaining quarter, in about equal shares.

Figure 25.3: Regional Fisheries and Aquaculture Value by Fishery Category



Source: Table 25.2.

General Observations

From a tuna fishery perspective, 2007, the focus year of this study, was not an unusual year—i.e., neutral to moderate La Niña oceanographic conditions, according to the manager of SPC's Oceanic Fisheries Programme (J. Hampton, personal communication, January 2009).

Total fisheries production in the region in 2007 is estimated to be 1,327,361 t, plus aquaculture production of 2,984 t and 305,336 pieces. The total value of fisheries and aquaculture production is estimated to be $2,049,463,587. Thus, the unit values across the region were

- coastal commercial : $3.70/kg
- coastal subsistence : $1.82/kg
- offshore locally based : $1.49/kg
- offshore foreign-based : $1.26/kg
- freshwater : $0.97/kg

The higher unit value of offshore locally based production relative to offshore foreign-based production reflects a higher proportion of locally based longlining and its high-value fresh tuna production. The lower value of freshwater production relative to coastal subsistence reflects the low imputed value of production in PNG's inland fisheries.

Comparing coastal fisheries production (commercial and subsistence) from independent countries (Tables 25.1 and 25.2) to the tuna production in those countries' zones from Forum Fisheries Agency (FFA) (2008), it can been seen that the tuna fisheries are almost eight times as large and almost six times as valuable as coastal fisheries.

Certain features are evident in the regional data. The most pronounced is that the ranking of countries by total fisheries production is strongly influenced by the level of tuna catches. Also, a general pattern of decreasing total national catches is seen from west to east across the region, and from equatorial to higher latitudes.

Other significant features are

- relatively large contribution, in both catch and value, of offshore foreign-based production in Kiribati, Federated States of Micronesia, Solomon Islands, Nauru, and Tuvalu;
- relatively large contribution of offshore locally based production in the Marshall Islands and (to a lesser extent) Fiji Islands;

- relatively large contribution of aquaculture production in French Polynesia and (to a lesser extent) New Caledonia; and
- relatively large contribution of non-tuna production in Fiji Islands.

Measuring the Production of Small-Scale Fisheries

In each of the country chapters, there are comments on the accuracy of the national production data. For most of the countries, there is a statement indicating the lack of good information for making estimates of small-scale fisheries production. From the experience gained during the present study, it seems that few, if any, of the long-established fisheries statistical systems supported by national governments (or more frequently, the remnants of old systems) provide good estimates of small-scale fisheries production.

In Fiji Islands, Vanuatu, Solomon Islands, and PNG, old surveys have come up with a "number" for small-scale fisheries production that has been institutionalized and used for years or decades with or without annual corrections.

Pacific island countries, in which there are relatively good estimates of national small-scale fisheries production, fall into three groups:

- countries that have a dedicated, ongoing, national fisheries statistical system supported for many years by an overseas agency; e.g., Guam, Northern Mariana Islands, and American Samoa;
- countries that have carried out an intensive, well-planned survey of fisheries to obtain an accurate snapshot. This has occurred recently in Fiji Islands, Palau, and Samoa in early 2000; and in Tokelau in late 1980s; and
- countries that use a household income and expenditure survey (HIES) for small-scale fisheries production purposes. The 2002 HIES in Samoa is the best example of using such a survey to obtain good estimates of coastal commercial and coastal subsistence catches.

The system in the first group above is not relevant to most Pacific island countries—a donor will unlikely come to the rescue of a fisheries statistical system and support it for many years/decades. However, in recent years, most Pacific island countries have had an HIES and all the independent Pacific island countries and several of the territories are planning for an HIES in the near future. Thus, using an HIES to estimate small-scale fisheries production deserves more attention. This is discussed in section 27.1.

Changes in Fishery Production during 1999–2007

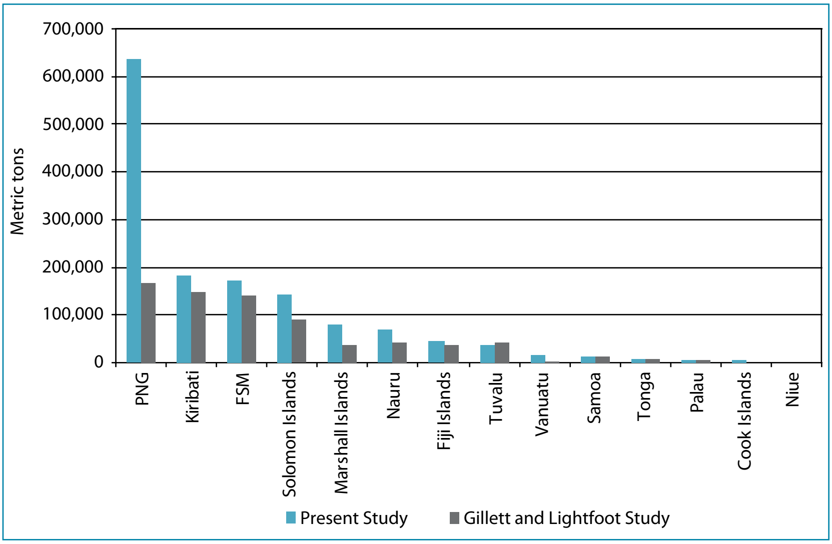
Between the Gillett and Lightfoot (2001) report and the present study, several significant changes have occurred in the fisheries sector of the Pacific islands. These concern the fishery resources, fishing practices, and policies at the national, regional, and international levels. They include

- emergence of a consensus that stocks of yellowfin and bigeye tuna are threatened by overfishing;
- increasing fishing pressure in many coastal areas, mostly caused by urbanization and population increases; and
- special and unprecedented prominence accorded to fisheries in the form of the Vava'u Declaration on Pacific Fisheries Resources at the 37th meeting of the heads of state and government of the Pacific island countries, October 2007.

Comparisons between the Gillett and Lightfoot (2001) report and the present study by value of production are also affected by varying levels of national inflation and exchange rates among countries. In addition, for the present study, a consistent system of valuing production was used (Chapter 1) whereas there was less uniformity in the method used by Gillett and Lightfoot (2001). Comparisons of production levels, however, are relatively straightforward. Figure 25.4 compares national fishery production estimates for the focus years. The figure shows a remarkable increase in production by PNG and a moderate increase by most other countries. Tuvalu suffered a decline, which can be attributed to inter-year fluctuations that are characteristic of offshore tuna fishing.

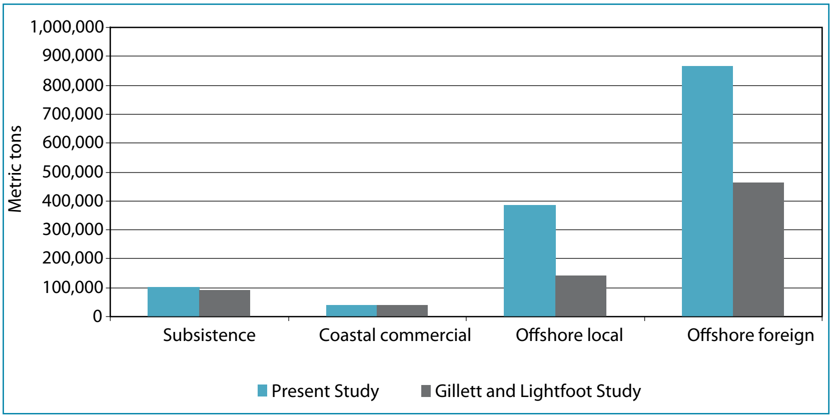
Figure 25.5 shows the changes between 1999 and 2007 by fishery category. The figure shows substantial production increases for offshore fisheries, while the coastal fishery production levels showed little change. A limitation of the comparison is that the 2007 estimates of offshore production consistently include bycatch in the estimates, whereas the 1999 estimate is less consistent in its bycatch treatment. Overall, this bycatch effect on relative production in 1999 versus 2007 is minor—and would certainly not produce the differences in offshore production visible in the figure.

Figure 25.4: National Fishery Production, 1999 and 2007 (t)



FSM = Federated States of Micronesia, PNG = Papua New Guinea, t = ton.
Source: Table 25.1 and Gillett and Lightfoot (2001).

Figure 25.5: Fishery Production by Category, 1999 and 2007 (t)



t = ton
Source: Table 25.2 and Gillett and Lightfoot (2001).

An important conclusion that can be drawn from the above information is that for the region as a whole, offshore fisheries expanded substantially while there was no overall production increase from coastal fisheries.

Aquaculture Production

General

Production from aquaculture deserves additional attention for several reasons. Aquaculture was not covered as a category in the 1999 study and could not be included in the above historical comparisons. Because of the mixture of units involved in measuring aquaculture production (quantities and pieces), it was not included in comparisons of production among countries. In the formulation of the present study, SPC (a major provider to the region of assistance in aquaculture) specifically requested that an evaluation of the benefits from aquaculture be included. Further, although there have been

Table 25.5: Value of Aquaculture Production, 2007

Country	**Farm-Gate Value of Production** ($)
French Polynesia	123,708,046
New Caledonia	16,594,253
Cook Islands	2,235,294
Fiji Islands	1,749,375
Guam	948,000
Papua New Guinea	675,676
Vanuatu	303,846
Northern Mariana Islands	205,000
Marshall Islands	130,000
Federated States of Micronesia	80,000
Kiribati	75,630
Palau	50,000
Solomon Islands	40,654
Samoa	33,206
Tonga	18,317
Nauru	15,126
American Samoa	10,000
Tuvalu	0
Wallis and Futuna	0
Niue	0
Tokelau	0
Pitcairn Islands	0
Total	**146,872,423**

Source: Country chapters of this report as given in Table 25.2.

substantial efforts to promote aquaculture in the region, there has been little analysis of the benefits from aquaculture that is independent of those promotion efforts.

As mentioned above, there is difficulty in measuring the quantity of total aquaculture production in the region due to the use of both tonnage and pieces to measure production. It is not meaningful to combine pieces of coral or giant clams with pearl pieces. An assessment by value is, however, straightforward. Information from the country chapters is used in Table 25.5 to estimate the total regional value of aquaculture. All values in this section are farm-gate values.

The overwhelming dominance of French Polynesia and, to a lesser extent, New Caledonia, is obvious in the table. In fact, 95.5% of the estimated \$146.9 million value of aquaculture in the 22 Pacific island countries and territories is from these two French territories.

SPC (2008b) gave a 50% greater value to regional aquaculture production—\$216 million (between \$160 and \$265 million). However, the two figures may not be strictly comparable because the type of price (farm-gate, free on board [FOB], or world market) and the year (or range of years) are not specified in the SPC paper.[1]

The value of regional production from fisheries and aquaculture (Figure 25.2) shows that the value of aquaculture production in the region is about equal to that of coastal commercial fishing or coastal subsistence fishing. However, most of that value is from the two French territories. Table 25.6 shows that for 16 countries in the region, aquaculture production represents less than 1% of the value of all fisheries and aquaculture. For nine countries, it is zero.

Stripping Away the Atypical

To examine aquaculture production in "typical" Pacific island countries, some insight can be obtained by eliminating from consideration French Polynesia and New Caledonia, which have a high degree of economic support from France and large subsidies for aquaculture (Mathieu 1998). For this exercise, PNG is also eliminated due to its relatively huge population (over twice that in all the other 21 countries of the region combined) and because over 87%

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1 Subsequent discussions with SPC aquaculture officers indicate that at least part of the difference in the estimates is due to SPC's contention that, for several aquaculture commodities, export prices are the same as farm-gate prices. This is not the view taken by the present study. On further reflection, there appears to be considerable justification for assuming that export prices for the aquaculture commodities covered in this report are greater than farm-gate prices.

Table 25.6: Share of Aquaculture Production in Value of All Fisheries and Aquaculture (%)

Country	Relative Value
Guam	69.2
French Polynesia	65.6
New Caledonia	33.4
Cook Islands	21.7
Northern Mariana Islands	11.5
Fiji Islands	1.7
Vanuatu	0.9
Palau	0.2
Papua New Guinea	0.1
Marshall Islands	0.1
Samoa	0.1
Tonga	0.1
American Samoa	0.1
Kiribati	0.0
Federated States of Micronesia	0.0
Solomon Islands	0.0
Nauru	0.0
Tuvalu	0.0
Wallis and Futuna	0.0
Niue	0.0
Tokelau	0.0
Pitcairn Islands	0.0

Source: Table 25.4.

of the population live inland and have no direct access to marine resources (Coates 1996). Clearly, these economies have aquaculture conditions that are *very* different from the rest of the region.

The general aquaculture production situation in the "typical" countries is summarized in Table 25.7. Minor and "promising" activities are not considered.

In general, nearly all the value of aquaculture production in the countries above came from

- private sector pearl culture operations in three countries,
- shrimp culture in three countries,
- tilapia and/or milkfish culture in several countries,
- giant clam culture in several countries, and
- seaweed culture in three countries.

Table 25.7: Aquaculture Production in Typical Pacific Island Countries

	Main Types of Aquaculture Production in 2007
Cook Islands	A total of 3,058 live giant clams were produced by the hatchery in 2007. Around 1,858 live juvenile clams were supplied for export to the aquarium trade, up from 320 juvenile clams in 2006. An additional 1,200 clams were transferred to Rarotonga for the coral gardens for tourists. Tilapia fry were imported by the government for a trial with a fish farmer in Rarotonga.
Federated States of Micronesia	Despite the long-term commitment from government and educational agencies, no economically sustainable aquaculture programs have been established to date. Presently, the only significant aquaculture operations are the culture of giant clams from the government aquaculture facility on Kosrae and of black pearls on Nukuoro Atoll.
Fiji Islands	Several pearl farms are operating. Other aquaculture production in 2007 consisted of 142.7 t of tilapia (worth F$712,300), 24.0 t of freshwater prawns (F$575,380), 13.0 t of brackishwater prawns (F$400,000), and 67.0 t of seaweed (F$33,500).
Kiribati	Aquaculture operations in 2007 included milkfish at Ambo—a few hundred kilos per month; seaweed—very little is grown in the Gilbert Group because of disease, with almost all Kiribati production from Fanning Island in the Line Group; and pearls—harvests in 2003 and 2008, with the latest harvest yielding a few hundred low-quality pearls.
Marshall Islands	In recent years, there have been two types of aquaculture with significant production: giant clams and black pearls. Some 20,000 to 30,000 baby clams have been produced, with a farm-gate price of about $3.50 apiece. The latest harvest of cultured black pearls was in early 2005, with about 2,000–3,000 pieces.
Nauru	The last estimate was in 2006; annual milkfish production was estimated at about 8 t.
Palau	In 2007, the aquaculture harvest was about 3,100 clams and 2 t of milkfish.
Samoa	Village giant clam nurseries are oriented toward enhancing the wild stock. Aquaculture harvesting is largely limited to tilapia. Annual harvest of cultured tilapia is unknown, but likely about 10 t/year.
Solomon Islands	Seaweed farming produces about 320 t annually, some coral is grown, and captured postlarval fish are reared.
Tonga	Aquaculture development in recent years has been slow and limited to stock enhancement largely at community level with little significant commercial production. By end 2007, about 12,134 clams worth $33,297 had been sold. Mabe pearls are produced by 3 or 4 people in Vava'u. About 200 pearls are produced each year.
Vanuatu	Aquaculture production is mainly shrimp—91% of the total value. Next most important is tilapia.
American Samoa	Production of tilapia in 2007 was 9 t.

continued on next page

Table 25.7: continuation

	Main Types of Aquaculture Production in 2007
Guam	Production in 2007 was: tilapia, 100 t (valued at $7/kg); milkfish, 40 t ($7/kg); catfish, 10 t ($6.60/kg); shrimp, 12 t ($28.75/kg). This equated to 162 t worth $1,391,000.
Northern Mariana Islands	In 2007, production from shrimp culture was about 10.9 t, with a farm-gate price of $17.60/kg, a premium price for live/fresh shrimp to the large local tourist industry. Tilapia production was about 227 kg/month, sold mainly at a farmer's market.
Niue	Zero
Pitcairn Islands	Zero
Tokelau	Zero
Tuvalu	Zero
Wallis and Futuna	Zero

F$ = Fiji dollar, kg = kilogram, t = ton.

Source: Country chapters of this report.

Many of the large-scale private sector pearl culture operations in Cook Islands, Fiji Islands, and Marshall Islands appear to be successful (consistent production in the absence of subsidies). They appear to offer a positive model for emulation in the region.

Substantial tilapia and/or milkfish culture exists in American Samoa, Cook Islands, Fiji Islands, Guam, Kiribati, Nauru, Northern Mariana Islands, Palau, Samoa, and Vanuatu, with a total combined production in 2007 of 346 t. Section 26.5 deals with aquaculture for production of local food and concludes that in most Pacific island countries, the food actually produced from tilapia and milkfish farms is quite small. In addition, many, if not most, of the tilapia and milkfish operations are government-subsidized.

Significant shrimp culture is carried out in Fiji Islands, Guam, Northern Mariana Islands, and Vanuatu. It appears to be highly dependent on demand from tourists and affluent residents. Exports are severely restrained by the economics (low volume, high production cost) of the international shrimp market.

A substantial amount of giant clam culture exists in the region. Nearly all the production is from government aquaculture facilities. Limited cost–benefit analyses have been carried out, with results only readily available for the Federated State of Micronesia (Preston 1999) and Tonga (Preston 1998). Those studies, which also consider the value of clam restocking, do not show very favorable cost–benefit ratios.

Seaweed is cultured in Fiji Islands, Kiribati, and Solomon Islands and is associated with significant donor support and government subsidies. There has been a marked production decline in recent years, specifically due to issues of disease and subsidy in Kiribati, and generally to competition with low-cost Asian producers. Value of total production in all three countries in 2007 was quite small, about $130,000.

In general, if aquaculture production from the atypical French territories and PNG is eliminated from consideration, significant aquaculture production comes from a limited range of activities: large-scale private sector pearl culture and shrimp culture where there is a significant tourist trade. There is significant tilapia/milkfish and giant clam culture, but whether net benefits are produced depends on the degree of subsidization, a situation that is often not clear.

With regard to shrimp, success (defined as consistent production in the absence of subsidies) is strongly related to tourism. It is doubtful if many of the shrimp aquaculture operations would be viable without tourists or a significant number of affluent local residents who can pay high prices for local produce. Not many Vanuatu citizens could afford to pay $30/kg for shrimp.

To some degree, tourism also helps pearl culture. About 5%–10% of local production of the largest pearl producer in Fiji Islands (and a disproportionate amount of profits) is from local sales. (J. Hunter, personal communication, January 2009). Sale of pearls to visitors to Marshall Islands is largely responsible for the very high farm-gate price ($50 each) for pearls in that country (M. Nair, personal communication, October 2008).

Success in aquaculture is also strongly associated with private sector operations. This has implications for the model used for aquaculture development and the distribution of aquaculture assistance.

Information in this section suggests that there is an important relationship between aquaculture production and subsidies. This subject is not prominent in the aquaculture literature of the region, but subsidies have a large effect on the net benefits from aquaculture. Other fisheries subsectors also receive subsidies and, therefore, the matter deserves attention. This is covered in section 29.2 of this report.

It is likely that aquaculture has produced benefits other than those that can be measured in terms of production (which is the subject of this chapter). Less tangible benefits include the creation of a conservation consciousness: that action must be taken to conserve clams.

Fishery Benefits Across the Region

Contribution of Fishing to GDP in the Pacific Island Countries

General

The official GDP and the official contribution of fishing to GDP in the countries and territories of the region are summarized in Table 26.1. The methods used in the official calculation of the fishing contribution to GDP are also presented. Some comments are made on the suitability of these methods. In some countries, the methods are well documented. In others, the information on methods was obtained verbally. More likely, some of this verbal information was inaccurate for various reasons, including the provider's unfamiliarity with the subject. This should be taken into account when considering the comments on any weakness in the methodology used in a particular country.

Certain features and patterns have emerged from investigating the methodology. One of the most common features concerns the individuals who work on national accounts. In many Pacific island countries, the individuals responsible for calculating the contribution of fishing to GDP (sometimes these individuals are responsible for all other sectors) appear to be unfamiliar with the technical basis of the methods they used for determining the fishing contribution. According to discussions with several such individuals, the methods presently used were developed by a colleague who had since departed.

Table 26.1: Official Estimates of GDP and Fishing Contribution to GDP

Country or Territory	GDP in Local Currency ('000, current market prices)	Fishing Contribution to GDP in Local Currency ('000)	GDP ($'000, current market prices)	Fishing Contribution to GDP ($'000)	Fishing Contribution as % of GDP	GDP Estimate Period
Cook Islands	286,711	18,113	210,817	13,318	6.3	2007
Federated States of Micronesia	236,900	n/a	236,900	n/a	n/a	FY2006
Fiji Islands	5,263,607	101,799	3,289,754	63,624	1.9	2007
Kiribati[a]	84,195	2,918	70,752	2,452	3.5	2007
Marshall Islands[b]	156,125	679	156,125	679	0.4	2007
Nauru	28,500	2,900	21,591	2,197	10.2	FY2006
Niue	17,341	736.6	10,082	428	4.2	FY2003
Palau	156,614	3,383	156,614	3,383	2.2	2006
Papua New Guinea	16,896,600	456,800	5,521,765	149,281	2.7	2006
Samoa	1,372,394	74,541	523,815	28,451	5.4	2007
Solomon Islands	3,497,700	208,400	459,619	27,385	6.0	2006
Tonga	478,226	20,148	243,993	10,280	4.2	FY2006
Tuvalu	26,944	2,220	14,723	1,213	8.2	2002
Vanuatu	51,979,579	403,867	499,804	3,883	0.8	2007
American Samoa	507,000	n/a	507	n/a	n/a	2002
French Polynesia	525,934,000	5,820,000	4,825,083	53,394	1.1	2005

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Table 26.1: continuation

Country or Territory	GDP in Local Currency ('000, current market prices)	Fishing Contribution to GDP in Local Currency ('000)	GDP ($'000, current market prices)	Fishing Contribution to GDP ($'000)	Fishing Contribution as % of GDP	GDP Estimate Period
Guam	3,678,500	n/a	3,678,500	n/a	n/a	2002
New Caledonia	768,000,000	n/a	7,045,872	n/a	n/a	2007
Northern Mariana Islands	1,002,000	n/a	1,002,000	n/a	n/a	2002
Pitcairn Islands	n/a	n/a	n/a	n/a	n/a	
Tokelau	n/a	n/a	n/a	n/a	n/a	
Wallis and Futuna	18,000,000	n/a	165,138	n/a	n/a	2007

FY = fiscal year, GDP = gross domestic product, n/a = not available.

[a] Subsistence in general is not included in the GDP and subsistence fishing is not included in the fishing contribution.

[b] Subsistence fishing not included in fishing value added. There is another sector called "subsistence" which includes subsistence fishing, but the precise proportion of fishing in that category is not clear.

Source: Country chapters of this report.

A “recipe” is now being followed, but the rationale for many components is apparently not well understood by these individuals.

Other important issues that have emerged are:

- Almost without exception, there is a great deal of enthusiasm among the staff of the various national statistics agencies to learn more about the fishing sector and to improve the estimation of its contribution to GDP.
- In the process of making fishing contribution estimates, there has been very limited or no involvement of people with expertise in fisheries in most countries. In two countries where there was involvement of fisheries department staff, the involvement was taken as proof of the validity of results, irrespective of the skills and experience of the fisheries person.
- Some surveys that gave the best estimates of small-scale fisheries in the region (e.g., those from Palau and Samoa) were unknown to the staff of the statistics units in those countries.
- Many countries have recently had, or are expecting to have in the near future, outside technical assistance for their national accounts from the Pacific Financial Technical Assistance Centre.
- A surprising number of GDP calculations dealing with fishing are done using input from a “specialized survey” or “informal survey,” almost none of which are available for examination. The results of some of these surveys appear incorrect to the point that one wonders whether a reasonable survey has indeed been undertaken (e.g., an extremely small VAR for a type of fishing that uses low technology).
- Many countries use the results of “business surveys” or tax records or provident fund (social security) records to determine the value added of commercial fishing. While this may be appropriate for large enterprises, small-scale commercial fishing activity may not be captured by the methodology.
- Most countries divide the fishing sector into smaller components, which have similar characteristics with respect to value added. Problems seem to occur when very dissimilar fisheries are aggregated into a single component (e.g., bêche de mer diving and reef gleaning) or when important fisheries are overlooked.
- Almost all countries use the results of HIES in the process of estimating production from small-scale fisheries for GDP purposes.

The accuracy of the HIES for fisheries purposes has a major impact on the fishing contribution to GDP across the region. This subject is covered in section 27.1 of this report.

Some important national issues on the accuracy of estimating the fishing contribution to GDP should be noted:

- In American Samoa, Guam, and the Northern Mariana Islands, the agriculture sector (which in those places includes fishing) is not included in the estimation of GDP.
- In Kiribati, subsistence activities (including subsistence fishing) are not included in the estimation of GDP. Subsistence in general was dropped from GDP calculations in the mid-2000s because there were no reliable data on which to base the estimates.
- In the Marshall Islands, at least some of the locally based foreign fishing activities should be considered part of the country's economy, according to international standards for national accounts statistics. This has a very large effect on the fishing contribution to GDP in that country.

Reestimating the Fishing Contribution to Gross Domestic Product

The fishing sector is complex. It can include thousands of producers operating in many locations and using a wide variety of techniques. Crews are often paid in kind or receive a share of the catch rather than wages; and even when they receive wages, collecting information on those wages can be difficult. Compared with other sectors in Pacific island economies (such as government, manufacturing, or tourism), calculating the contribution of fishing to an economy is a particularly difficult task.

As part of the present study, a reeestimate was made of the fishing contribution to GDP in each country. This presents an alternative to the official method of estimating fishing contribution to GDP. The reestimate does not intend to replace the official methodology, but rather the results can serve as a comparator to gain additional information on the appropriateness and accuracy of the official methodology—and possibly a need for modification.

The reestimate for each country and the associated methodology are given in the country chapters of this report. The results are summarized and compared to the official estimate (where available) in Table 26.2. This is shown graphically in Figure 26.1.

Table 26.2: Official Estimates and Reestimates of Fishing Contribution to GDP

Country	Official Fishing Contribution to GDP in Local Currency ('000)	Official Fishing Contribution Share of GDP (%)	Consultant's Reestimate of Fishing Contribution to GDP in Local Currency ('000)	Consultant's Reestimate of Official Fishing Contribution Share of GDP (%)	Period for Estimates (Calendar year unless noted)	
					Official	Reestimate
Cook Islands	18,113	6.3	4,011	1.4	2007	2007
Federated States of Micronesia	n/a	n/a	23,750	10.0	FY2006	2006
Fiji Islands	101,799	1.9	27,761	1.7	2007	2007
Kiribati[a]	2,918	3.5	44,965	53.4	2007	2007
Marshall Islands[b]	679	0.4	41,763	26.7	2007	2007
Nauru	2,900	10.2	1,321	4.6	FY2006	mid-2000s
Niue	736.6	4.2	766	4.4	FY2003	2003
Palau	3,383	2.2	9,573	6.1	2006	2006
Papua New Guinea	456,800	2.7	153,910	3.1	2006	2006
Samoa	74,541	5.4	85,043	6.2	2007	2007
Solomon Islands	208,400	6.0	236,448	6.8	2006	2007
Tonga	20,148	4.2	24,188	5.1	FY2006	FY2006
Tuvalu	2,220	8.2	1,258,622	10.3	2002	2002
Vanuatu	403,867	0.8	696,350	1.3	2007	2007

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Table 26.1: continuation

Country	Official Fishing Contribution to GDP in Local Currency ('000)	Official Fishing Contribution Share of GDP (%)	Consultant's Reestimate of Fishing Contribution to GDP in Local Currency ('000)	Consultant's Reestimate of Official Fishing Contribution Share of GDP (%)	Period for Estimates (Calendar year unless noted)	
					Official	Reestimate
American Samoa	n/a	n/a	3,359	0.7	2002	2007
French Polynesia	5,820,000	1.1	7,206,568	1.4	2005	2007
Guam	n/a	n/a	904	0.0	2002	2007
New Caledonia	n/a	n/a	2,391,258	0.3	2007	2007
Northern Mariana Islands	n/a	n/a	12,815,683	0.1	2002	2007
Pitcairn Islands	n/a	n/a	81	n/a	-----	2007
Tokelau	n/a	n/a	726	n/a	-----	2007
Wallis and Futuna	n/a	n/a	509,050	2.8	2005	2007

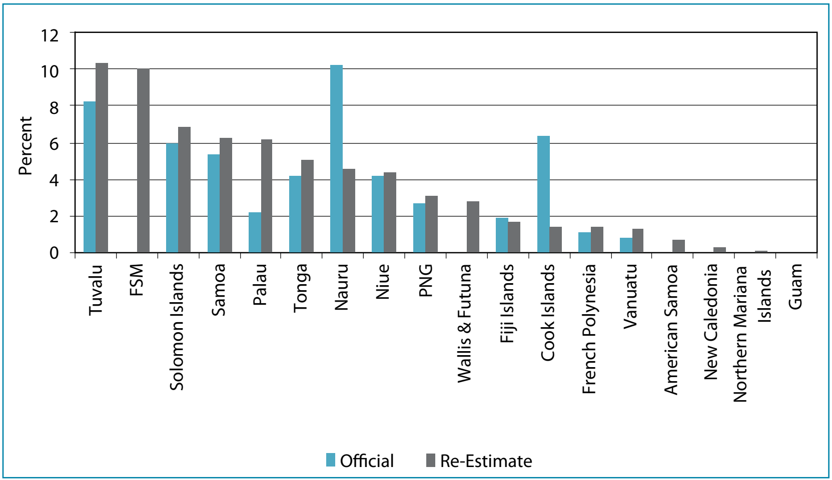
FY = fiscal year, GDP = gross domestic product, n/a = not available.

[a] Subsistence in general is not included in the GDP and subsistence fishing is not included in the fishing contribution.

[b] Subsistence fishing not included in fishing value added. There is another sector called "subsistence" which includes subsistence fishing, but the precise proportion of fishing in that category is not clear.

Source: Country chapters of this report.

Figure 26.1: Official versus Reestimate of Fishing Contribution to GDP



FSM = Federated States of Micronesia, GDP = gross domestic product, PNG = Papua New Guinea.
Source: Table 26.2.

Some explanations and caveats are required for the table and figure, as follows:

- The reestimate percentage contribution of fishing is simply the new fishing contribution divided by the GDP. No attempt is made (unless otherwise stated in the country chapter) to adjust national GDP to account for any significant increase/decrease in GDP due to a reestimated fishing contribution.
- Kiribati is not shown in Figure 26.1 because it is not appropriate to compare the reestimated fishing contribution to GDP (which includes subsistence fishing) with the national GDP (which does not include any subsistence activities of any type). The reestimated fishing contribution method is more than half of the entire official 2007 GDP of Kiribati.
- For the Marshall Islands, the recalculated fishing contribution to GDP is many times greater than the official contribution, but a comparison is not appropriate because the official contribution of subsistence fishing is both not readily apparent and placed in a category with all subsistence activities.

Note that in the above table and figure, for most locations the reestimate was larger than the official figure, and in two locations (Nauru and Cook

Islands) the reestimate was substantially smaller. On the basis of good knowledge of the fisheries sector, the results in those two countries are likely to be erroneous.

Some of the reasons for the difference between the official estimate and the reestimate are

- including or excluding the activities of locally based foreign fishing vessels;
- official estimate omitting certain important fisheries;
- value added from offshore fisheries being determined in the official method from a survey of businesses, rather than using reliable production figures;
- value added from small-scale fishing (coastal commercial and subsistence fishing) differing between the official and reestimate, in some cases because estimates of production differ, in others because the VAR is different; and
- production estimates from the "informal" and "specialized" studies of the fishing sector in the official method often differing greatly from those obtained from the present study.

The main lesson learned is that, in countries where the estimates are markedly different from the reestimate, the process of preparing the national accounts tends to rely on outdated surveys, inappropriate indicators, and/or poorly understood methods. In most of these cases, the compilers of national accounts do not appear to have consulted the relevant fisheries agencies or the industry when preparing their estimates.

Contribution by Fishery Category

In this study, reestimates of fishing contribution to GDP for each country were done by uniform fishery categories across the region. They are compiled and compared in Table 26.3.

The regional contributions of each fishery category are shown graphically in Figure 26.2. Some interesting features emerge:

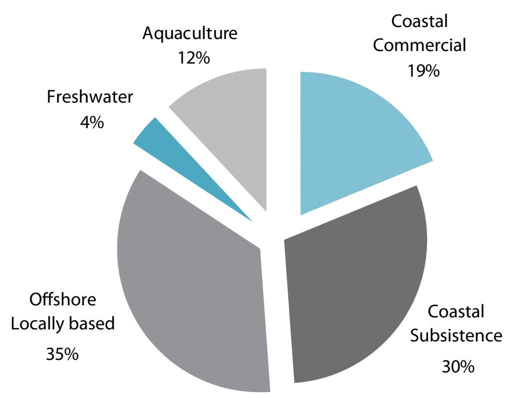
- Coastal subsistence fishing (because of its high VAR) assumes a greater relative importance in GDP contribution than in catch value contribution.

Table 26.3: Value Added by Fishery Category ($)

Country	Coastal Commercial	Coastal Subsistence	Offshore Locally Based	Freshwater	Aquaculture
Cook Islands	669,118	1,000,000	241,176	33,088	1,005,882
Federated States of Micronesia	5,670,000	13,372,200	9,444,132	7,600	44,000
Fiji Islands	18,562,500	27,050,000	5,858,750	3,858,750	874,688
Kiribati	12,016,807	25,714,286	0	0	54,454
Marshall Islands	2,175,000	3,665,200	35,851,258	0	71,500
Nauru	504,202	595,210	0	0	10,588
Niue	30,233	415,116	291,628	0	0
Palau	1,990,100	2,008,800	5,536,737	7,600	30,000
Papua New Guinea	16,993,464	30,718,954	109,058,791	15,212,418	424,837
Samoa	15,646,073	13,413,458	3,345,134	29,885	24,573
Solomon Islands	2,186,275	9,882,353	17,464,251	1,346,928	28,458
Tonga	6,979,592	4,778,571	571,429	1,939	9,439
Tuvalu	280,637	1,234,078	0	0	0
Vanuatu	1,523,846	4,879,327	0	155,769	136,731
American Samoa	114,540	406,300	2,827,017	3,600	7,400
French Polynesia	12,652,529	8,448,276	5,649,460	415,230	55,668,621
Guam	117,000	162,750	0	8,500	616,200
New Caledonia	5,648,276	12,616,092	1,712,644	41,297	7,467,414
Northern Mariana Islands	570,000	505,360	0	0	92,250
Pitcairn Islands	24,375	34,926	0	0	0
Tokelau	0	533,547,794	0	0	0
Wallis and Futuna	784,483	5,066,667	0	0	0
Total	**105,139,048**	**166,501,472**	**197,852,407**	**21,122,605**	**66,567,033**

Source: Country chapters of this report.

Figure 26.2: Contribution to GDP by Fishery Category



GDP = gross domestic product.

Source: Table 26.3.

- Offshore locally based fishing (because of its low VAR) assumes a lesser relative importance in GDP contribution than in catch value contribution.
- Coastal subsistence fishing and offshore locally based fishing are each responsible for about a third of all fishing contribution to GDP, with the other three categories combined responsible for the other third.

To a certain degree, the fishery categories above could represent ecological zones. This subject is explored in section 26.6.

Changes in Fisheries Contribution

Another aspect of the fishing contributions to GDP is their change over time. Gillett and Lightfoot (2001) gave the fishing contributions to GDP of the independent Pacific island countries for about a decade earlier. Those values are compared with the values of the present study in Table 26.4 and Figure 26.3.

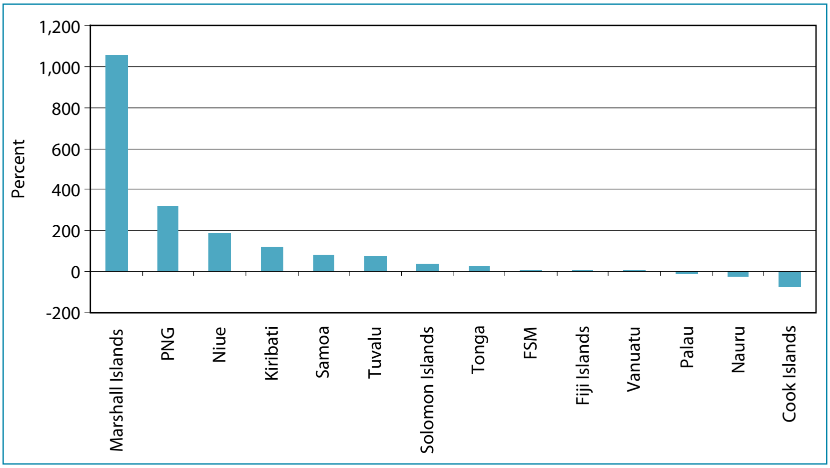
Table 26.4: Fishing Contribution to GDP, from Gillett and Lightfoot and Present Study

Country	Contribution Estimated by Gillett and Lightfoot (Local currency, '000)	Contribution Estimated by Present Study (Local currency, '000)	Period for Estimates (Calendar year unless noted)	
			Gillett and Lightfoot	Present Study
Cook Islands	17,343	4,011	2000	2007
Fiji Islands	84,616	89,928	1999	2006
Federated States of Micronesia	21,950	23,750	1998	2007
Kiribati	20,232	44,965	2000	2007
Marshall Islands	3,605	41,763	1999	2007
Nauru	1,696	1,321	1999	mid-2000s
Niue	266	766	2000	2003
Palau	11,027	9,573	1998	2006
Papua New Guinea	125,391	527,570	1999	2006
Samoa	46,246	85,043	1999	2007
Solomon Islands	173,174	236,448	1999	2007
Tonga	18,808	24,188	1999/2000	FY2006
Tuvalu	1,556	2,772	1998	2002
Vanuatu	663,924	696,350	1999	2002

GDP = gross domestic product.

Source: Table 26.2 and Gillett and Lightfoot (2001).

Figure 26.3: Percentage Change in Fishing Contribution to GDP between Gillett and Lightfoot and Present Study



FSM = Federal States of Micronesia, GDP = gross domestic product, PNG = Papua New Guinea.

Source: Table 26.4.

Changes in fishing contributions to GDP over the time intervals in Table 26.4 were greatest in the Marshall Islands (with the establishment of a locally based offshore fleet) and PNG (with increased activity of the locally based offshore fleet). Fishing contributions to GDP decreased the most in Cook Islands (due to decrease in production from pearl farming) and Nauru (due to termination of locally based offshore fishing and decrease in coastal commercial fishing). At least some of the observed changes (or real changes that were masked) were due to improved estimates of various categories of fishing. For example, in Fiji Islands, a 2008 survey resulted in a substantial change in subsistence fisheries production estimate from that used in the Gillett and Lightfoot (2001) survey.

Improving the Official Estimate of Fishing Contribution to GDP

General improvements in estimating GDP are far beyond the scope of the present project. However, there are some simple ways that can help improve the accuracy of estimating the fishing contribution to GDP, as follows:

- **Expertise.** Statistics staff should obtain technical fisheries expertise when devising methodology, collecting data, making the estimate, and reviewing the results. In addition to government fisheries agencies, there is fisheries expertise in the private sector and Pacific island countries have access to relevant expertise from the regional agencies.

- **Evaluate Reestimates.** Compare the reestimated fishing value added in the country chapters of this report to the official estimate and evaluate the differences and any need for modification to the methodology.
- When using the production approach for estimating fishing contribution to GDP, the following may be useful:

  i) **Categories.** Formulate logical fisheries categories that group similar fisheries with similar VARs. The present study uses the categories of coastal commercial, coastal subsistence, offshore locally based, offshore foreign-based, freshwater, and aquaculture. Other categories may be more appropriate in some countries, while the smaller countries may have fewer categories.

  ii) **VARs.** In the absence of specialized economic studies for the concerned country, use the suggested VARs of Appendix 3 of this report.

  iii) **Offshore Production Estimates.** For estimates of offshore fisheries production, use the WCPFC national fisheries reports. All Pacific island countries prepare these for the annual meeting of the Scientific Committee of the WCPFC (available at www.wcpfc.int). The staff of government fisheries agency or the FFA can place values on the tonnage of fisheries production in the document.

Exports of Fishery Products

National Data and Comparisons

The readily available information on the export of fishery products is presented in the country chapters in this report and summarized in Table 26.5 below. Data presented are for 2007, unless otherwise stated. Aquaculture products are included in the term "fishery products."

Some of the difficulties encountered when using and comparing export data mainly involved the treatment of exports of domestic vessels when those vessels unloaded in a foreign port, and reexports, both at the fishery level

Table 26.5: Value of Exports of Fishery Products from the Pacific Islands

Country	Nominal Value (local currency)	Nominal Value ($)	Share of All Exports (%)	Details
Cook Islands	NZ$5,598,000	4,120,828	79.4	Aquarium fish are worth NZ$62,000. "Fresh fish" are 1/3 more than pearls.
Federated States of Micronesia	$12,301,318	12,301,318	76	Exports from offshore fishing account for 91% of exports.
Fiji Islands	F$101,300,000	63,217,953	12.2	Tuna exports dominate, with other important commodities being marine aquarium items, bêche de mer, trochus, and deepwater snapper.
Kiribati	A$2,500,000	1,893,375	58	Data are for 2006. Aquarium fish are the largest component. Seaweed exports have fallen markedly in recent years.
Marshall Islands	$37,342,000	37,342,000	4.3	Data are for 2006. Tuna exports are the most important fishery export. Aquarium fish are the largest component of the coastal exports. Export data in 2005 and 2006 are distorted by sales of ships. Fishery exports averaged 30% of all exports in 2002–2004.
Nauru	0	0	0	Currently, there is no export of fishery products. The last export of fresh tuna from the domestic longline operation was in 2001.
Niue	n/a	n/a	90	Unpublished data from Customs Niue indicate that fish exports were 88.5 tons in 2005, 403.6 tons in 2006, and 602.2 tons in 2007.
Palau	$19,000,000	19,000,000	100	Tuna exports dominate, with other important commodities being marine aquarium items, trochus, and coral.
Papua New Guinea	K299,000,000	101,000,000	1.3	Major exports are tuna products ($88 million) and other fish, lobster, shellfish, and shrimp (about $13 million combined).
Samoa	ST20,000,000	7,634,000	55.3	Since 1997, export bans on several types of fishery products (coral, aquarium fish, and bêche de mer) have resulted in almost all commercial fishery exports in recent years being tuna products.
Solomon Islands	SI$151,392,000	19,784,631	12	The major commodities are tuna (by far the largest), bêche de mer, trochus, aquarium products, seaweed, and shark fins.

continued on next page

Table 26.5: continuation

Country	Nominal Value (local currency)	Nominal Value ($)	Share of All Exports (%)	Details
Tonga	T$9,800,000	4,861,780	46.9	Data are for FY2007. The major exports by percentage of value were tuna (29%), live rock (21%), soft coral (12%), snapper (11%), and aquarium fish (10%).
Tuvalu	A$5,000	4,216	100	The only significant exports in recent years were bêche de mer and aluminum scraps (crushed cans), with the latter actually being a reexport.
Vanuatu	Vt130,400,000	1,230,189	3.4	Data are the average for 2004–2007. Trochus, bêche de mer, and aquarium products dominated exports.
American Samoa	438,529,360	438,529,360	100	Data are for 2006. Small amounts of fresh fish were occasionally shipped to Hawaii, but this trade was insignificant compared to the export of tuna products from canneries.
French Polynesia	CFP11,169,000,000	128,379,310	71.5	Pearl products made up 96% of all fishery exports. Pelagic fish made up slightly more than half of the non-pearl fishery exports.
Guam	n/a	n/a	n/a	Exports of "fish, chilled, fresh, frozen, dried, and salted" were $11.8 million in 2007, but almost all were likely from the transshipping longliners and were not bona fide exports.
New Caledonia	CFP13,651,000,000	156,908,046	1.1	Cultured shrimp made up 68% of fishery exports. Bêche de mer, tuna, and trochus were also important.
Northern Mariana Islands	0	0	0	There was no significant commercial export of fishery products. Any fish sent overseas was largely for family and friends in Hawaii and mainland United States.
Pitcairn Islands	NZ$51,000	37,542	n/a	The fish sold to ships and yachts could be considered export. They were sold to foreigners, usually paid in a foreign currency, and mostly consumed away from the country.
Tokelau	n/a	n/a	n/a	There was no monitoring of Tokelau exports.
Wallis and Futuna	CFP6,800,000	78,161	100	The only officially documented export in 2007 was trochus.

A$ = Australian dollar, CFP = Pacific franc, F$ = Fiji dollar, FY = fiscal year, K = kina, n/a = not available, SI$ = Solomon Islands dollar, ST = tala, T$ = pa'anga, Vt = vatu.

Data are for 2007, unless otherwise noted; prices are free on board (FOB); official data are used where available.

Source: Country chapters of this report.

(e.g., what transshipped fish to include) and at the national level—periodic exports of cars and ships tended to deflate the relative importance of exports from other sectors.

Figures 26.4 and 26.5 show the nominal value of the fishery exports and the value of fishery exports relative to total national exports. The most important feature is that fishery exports are very important to the countries of the region. In about half of the countries, fishery exports represent over half of all exports. Where they represent less than half the value of national exports, they are mostly quite large in nominal terms: New Caledonia ($157 million), PNG ($101 million), Fiji Islands ($63 million), and Marshall Islands ($37 million).

The three entities that have the largest value of exports are American Samoa, New Caledonia, and French Polynesia—ironically, all satellite or dependent territories. Of the total $996 million in fishery exports in 2007, about three-quarters are from these three territories.

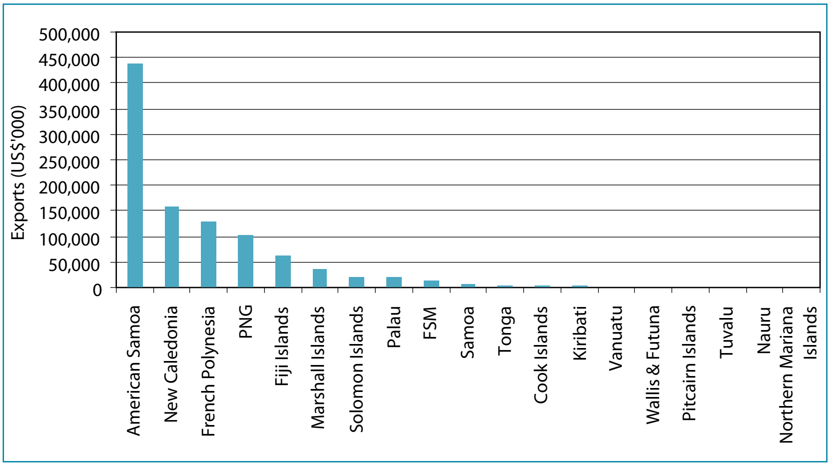
In terms of export commodities, the most important in value by far are tuna products. Tuna exports from American Samoa alone approach the value of *all* other fishery exports in *all* other Pacific island countries combined. Determining the precise regional value of tuna exports (or other export commodities) is difficult due to unavailability of export statistics disaggregated to the commodity level in some countries. In 2007, 14 of the 22 countries and territories exported substantial amounts of tuna products.

Aquaculture exports in 2007 were dominated by pearl culture in French Polynesia ($123 million), shrimp culture in New Caledonia ($107 million), and pearl culture in the Cook Islands ($1.6 million). These three types of operations were responsible for about one quarter of all fishery exports in all the countries of the region in 2007.

Other interesting aspects of regional fishery exports are:

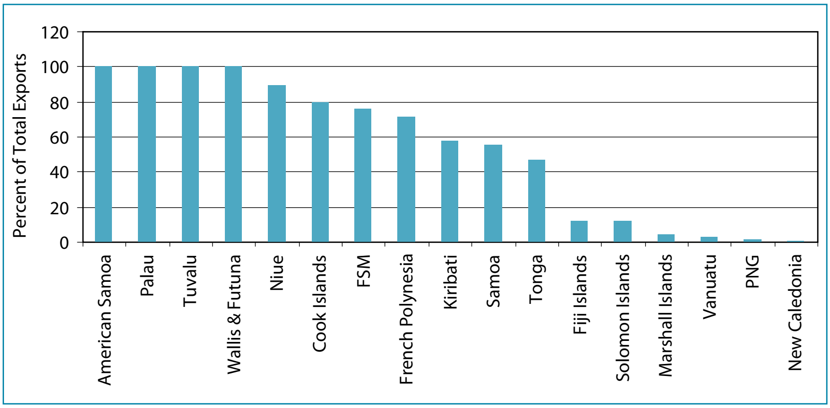
- In two countries that are major fishery exporters (PNG and New Caledonia) the relative importance of the fishery exports is dwarfed by other exports.
- For many countries in which fishery exports are more than half of all exports, only several of them export tiny quantities: Niue, Tuvalu, and Wallis and Futuna.
- Several countries located in areas of good tuna fishing (as judged by access fees) export little or no tuna: Kiribati, Nauru, Tokelau, and Tuvalu.
- Export of aquarium products is significant in 10 countries.

Figure 26.4: Annual Value of Fishery Exports



FSM = Federated States of Micronesia, PNG = Papua New Guinea.
Data are for 2007, unless otherwise noted in the table.
Source: Table 26.5.

Figure 26.5: Fishery Share of Value of All Exports (%)



FSM = Federated States of Micronesia, PNG = Papua New Guinea.
Data are for 2007, unless otherwise noted in the table.
Source: Table26.5.

Change in the Value of Fishery Exports

Another aspect of fishery exports is their change over time. Gillett and Lightfoot (2001) gave export values for the independent Pacific island countries for 1999. Those values are compared with the values of the present study (for 2007) in Table 26.6 and Figure 26.6.

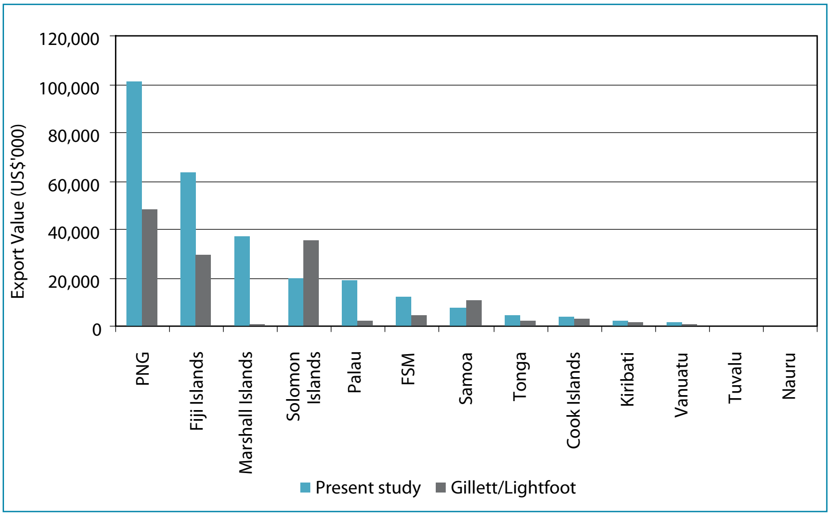
Fishery exports increased from 1999 to 2007 in most countries. They fell significantly, however, in the Solomon Islands (due to a deteriorating currency exchange rate) and Samoa, where a fall occurred despite an improved exchange rate. In some cases (e.g., FSM), increases in fishery exports may be related to improvements in defining and monitoring exports. Total fishery exports of the countries compared almost doubled in nominal terms in the 6 years between the two studies.

Table 26.6: Change in the Value of Fishery Exports ($)

Country	Gillett and Lightfoot (for 1999)	Present Study (for 2007)
Papua New Guinea	48,106,666	101,000,000
Fiji Islands	29,193,745	63,217,953
Marshall Islands	473,000	37,342,000
Solomon Islands	35,472,033	19,784,631
Palau	2,213,419	19,000,000
Federated States of Micronesia	4,878,387	12,301,318
Samoa	10,785,287	7,634,000
Tonga	2,573,670	4,861,780
Cook Islands	2,919,136	4,120,828
Kiribati	1,483,871	1,893,375
Vanuatu	394,954	1,230,189
Tuvalu	4,233	4,216
Nauru	0	0
Total	**138,498,401**	**272,390,290**

Sources: Gillett and Lightfoot (2001) and Table 26.5.

Figure 26.6: Change in the Value of Fishery Exports



FSM = Federated States of Micronesia, PNG = Papua New Guinea.
Sources: Gillett and Lightfoot (2001) and Table 26.6.

Difficulties in Measuring Fishery Exports

In the course of collecting and compiling information on fishery exports, a number of observations were made on the accuracy of data. Most notable was the apparent underestimation of the value of fishery exports. This underestimation appeared large and relatively worse than in other trade sectors. In most cases, when the official export values were compared with other sources of similar information (e.g., importing country information, Convention on International Trade in Endangered Species [CITES] records, audited exporting company accounts), the differences were remarkable.

Possible reasons for the differences are (i) most government customs departments are oriented to taxing imports and may give low priority to documenting exports; (ii) keeping track of fishery exports is more complex than for other major commodities due to the presence of many exporters, a multitude of different products each with different values, large numbers of small shipments, and many different export points; and (iii) often there is no examination by customs departments of the exported commodities.

Further, in many countries, products that would often be considered fisheries products, such as coral, are not captured in the official export statistics. In some countries, fishery exports are confined to finfish, while other countries specifically list a few important fishery exports and put others together with miscellaneous nonfishery commodities. Consequently, the total value of fishery exports cannot be easily determined from official publications.

Government Revenue from Fisheries

Access Fees for Foreign Fishing

In each of the country chapters of this report, information is provided on access fees received for foreign fishing. Table 26.7 summarizes the fees paid for the most recent annual period for which data are available and compares those fees to the national revenue and to population. Access fee payments are shown graphically in Figure 26.7.

Table 26.7: Access Fees for Foreign Fishing

Country	Access Fees in Local Currency (year)	Access Fees ($)	Access Fees Share of Government Revenue (%)	Access Fees per Capita ($)
Cook Islands	NZ$356,320 (2007)	262,000	0.4	17
Fiji Islands	F$411,176 (2007)[a]	256,985	0.03	0
Federated States of Micronesia	$14,757,221 (2007)	14,757,221	10.2	134
Kiribati	A$25,419,845 (2007)	21,361,214	41.7	228
Marshall Islands	$1,953,644 (2007)	1,953,644	5.4	37
Nauru	A$6,126,000 (FY2007/08)	5,147,899	17.2	518
Niue	NZ$382,775 (FY2006/07)	263,983	2.3	166
Palau	$1,121,281 (FY2007)	1,121,281	3.2	55
Papua New Guinea	K44,300,000 (2007)	14,966,216	0.6	2
Samoa	ST663,021 (2007/08)	256,985	0.15	1
Solomon Islands	SI$90,000,000 (2007)	11,764,705	4.4	23
Tokelau	NZ$2,011,000 (2007)	1,478,676	11.8	1,264
Tonga	T$267,057 (2007)	132,206	0.2	1
Tuvalu	A$4,100,000 (2007)	3,445,378	11.3	355
Vanuatu[b]	Vt149,567,538 (2006)	1,359,700	1.7	6

A$ = Australian dollar, F$ = Fiji dollar, FY = fiscal year, K = kina, NZ$ = New Zealand dollar, SI$ = Solomon Islands dollar, ST = tala, T$ = pa'anga, Vt = vatu.

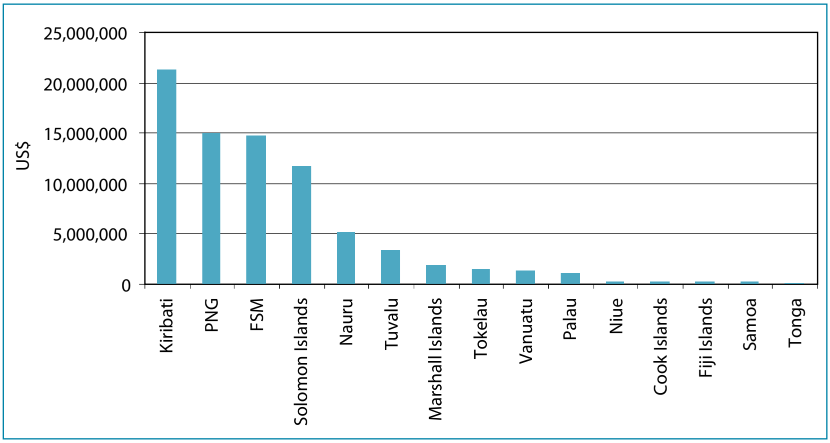
[a] Fiji Islands has access fees for its locally based offshore fleet (F$525,000 in 2006), but these are applied to both Fiji Islands and foreign-registered vessels, and are, therefore, not considered here as fees for foreign fishing.
[b] No access fee data are available for Vanuatu later than 2006. Those 2006 payments are matched with 2006 government revenue.

Source: Country chapters of this report; population information from the introduction to this report.

There are several explanations and caveats for the information in Table 26.7:

- Some Pacific island countries consider that all payments under the US tuna treaty are for fishing access, while others treat some components as aid. Unless otherwise stated in a readily available government document, all US tuna treaty payments are assumed to be for access.
- Exchange rates used are the ADB average-of-year rates given at the beginning of this report.
- "Government revenue" is defined in various ways in the countries of the region. More information on what is included in "Government revenue" (if available) is given in the individual country chapters.
- The annual periods associated with fee payments and government revenue in many cases do not always correspond (i.e., a calendar year and a financial year). Given the limited information available, this is unavoidable.
- The access fees listed are (wherever possible) taken from government budget documents in the public domain and represent money actually received. The sources of information are specified in the country chapters.

Figure 26.7: Access Fees Paid for Foreign Fishing



FSM = Federated States of Micronesia, PNG = Papua New Guinea.
Source: Table 26.7.

Another important aspect of foreign access fees is their value compared to the value of the catch made by the fee-paying fleets in a country's zone. Table 26.8 uses the amount of access fees from Table 26.7 and compares it to the value of the foreign catch in a country's zone. Some explanation is required, as follows:

- The "value of foreign catch" is derived from estimates of foreign-based offshore fishing in the country chapters. Rather than "landed values," these values are the "in-zone" values (i.e., destination market values adjusted for cost of transport to those markets)—closer to the real economic value of the catch.
- The values given are for calendar year 2007 (2006 for Vanuatu) while the access fees are sometimes for a slightly different annual period (e.g., FY2007).
- Due to the presence in some countries of foreign locally based fleets that pay foreign access fees, some adjustments have been made, as noted in the table.

Table 26.8: Access Fee Payments Relative to the Value of the In-Zone Foreign Catch

Country	Access Fees (local currency)	Value of Offshore Foreign-based Catch (local currency)	Access Fees Share of the Foreign Catch Value	Comment
Cook Islands	356,320	0	Large	Access fees were paid by a fleet that did not fish in the zone in 2007.
Fiji Islands	411,176	844,000	48.7	Access fees were paid but there was only a small amount of foreign fishing.
Federated States of Micronesia	14,757,221	185,562,446	8.0	As the fees included those from locally based foreign fishing, the value of the catch from locally based longlining was added to the value of the foreign-based catch.
Kiribati	25,419,845	232,714,135	10.9	The value of catch of foreign-based locally registered purse seiner ("Kao," which presumably did not pay Kiribati access fees) was subtracted from the value of the foreign-based catch in the zone.

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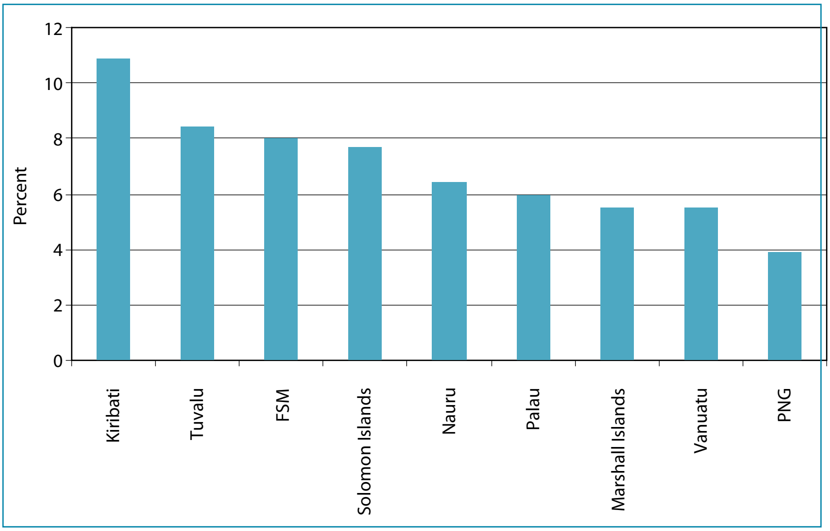
Table 26.8: continuation

Country	Access Fees (local currency)	Value of Offshore Foreign-based Catch (local currency)	Access Fees Share of the Foreign Catch Value	Comment
Marshall Islands	1,953,644	35,419,168	5.5	Because the fees included those from locally based foreign fishing, the value of catch from locally based longlining was added to the value of the foreign-based catch.
Nauru	6,126,000	95,201,620	6.4	
Niue	382,775	0	Large	Access fees were paid but there was no foreign fishing.
Palau	1,121,281	18,747,152	6.0	Because the fees included those from locally based foreign fishing, the value of catch from locally based longlining was added to the value of the foreign-based catch.
Papua New Guinea	44,300,000	1,143,631,355	3.9	This was the "access fee income" divided by the value of catches in PNG waters by foreign-based fleets.
Samoa	663,021	129,166	513.3	Access fees were paid but there was only a small amount of foreign fishing.
Solomon Islands	90,000,000	1,174,648,841	7.7	
Tokelau	2,011,000	540,484	372.1	Access fees were paid but there was only a small amount of foreign fishing.
Tonga	267,057	0	Large	Access fees were paid but there was no foreign fishing.
Tuvalu	4,100,000	48,700,000	8.4	Catch was relatively large in 2007.
Vanuatu	149,567,538	2,704,380,286	5.5	Fees paid and catch value are for 2006.

Source: Table 26.7 and country chapters of this report.

The results from the table (less the outliers) are shown graphically in Figure 26.8. In comparing access fees between countries, it should be noted that some countries (e.g., PNG) charge lower rates to foreign vessels that are locally based to encourage such local basing.

Figure 26.8: Access Fee Payments Relative to the Value of the Foreign Catch



FSM = Federated States of Micronesia, PNG = Papua New Guinea.
Source: Table 26.8.

The comparisons above between access fees and catch values are for one year only. Given the characteristic variability of catches by tuna fishing in a national zone, a more informative approach would be to average several years of data. In Tuvalu, for example, over the 5 years 2003–2007, access fees averaged A$3.63 million/year, or 14.6% of the value of the fish caught. Unfortunately, such information is readily available for only a few countries in the region.

All independent Pacific island countries receive at least some access fees for foreign fishing in their zones. Only one Pacific Island territory, Tokelau, presently licenses foreign fishing vessels and receives access fees. Payments from the US tuna treaty represent all or almost all of the access fees in the Cook Islands, Fiji Islands, Niue, Samoa, and Tonga. The US fleet has never done any significant amount of fishing in Tonga or Niue (where US treaty payments averaged $166 per person in the latest annual period), and only tiny catches have been made in the Cook Islands, Fiji Islands, and Samoa.

Table 26.9 gives the access fees and the changes in fees between 1999 (Gillett and Lightfoot 2001) and the present study (2007) for the countries covered in both studies. The fees increased in nominal terms for all but three

Table 26.9: Changes in Access Fees, 1999–2007

Country	Access Fees 2007 ($)	Access Fees 1999 ($)	Change ($)	Change (%)
Cook Islands	262,000	169,072	92,928	35.5
Fiji Islands	256,985	212,000	44,985	17.5
Federated States of Micronesia	14,757,221	15,400,000	(642,779)	(4.4)
Kiribati	21,361,214	20,600,000	761,214	3.6
Marshall Islands	1,953,644	4,982,699	(3,029,055)	(155.0)
Nauru	5,147,899	3,400,000	1,747,899	34.0
Niue	263,983	151,793	112,190	42.5
Palau	1,121,281	800,000	321,281	28.7
Papua New Guinea	14,966,216	5,840,000	9,126,216	61.0
Samoa	256,985	188,616	68,369	26.6
Solomon Islands	11,764,705	273,458	11,491,247	97.7
Tonga	132,206	152,041	(19,835)	(15.0)
Tuvalu	3,445,378	5,900,000	(2,454,622)	(71.2)
Vanuatu	1,359,700	218,448	1,141,252	83.9
Total	**77,049,417**	**58,288,127**	**18,761,290**	**24.3**

( ) = negative.
Sources: Table 26.8 and Gillett and Lightfoot (2001).

countries, with an overall increase of almost one-quarter ($18.7 million) in the 7 years between the estimates. It should be noted that access fees can fluctuate widely year to year because of many factors (e.g., fleet movements, exchange rates), and comparing an average of several years (e.g., a moving 5-year average) would be more informative.

The total access fees in the table ($77,049,417) do not include Tokelau, for which the access fees were $1,478,676 in 2007 (Tokelau was not included in the earlier study). The total access fees paid regionwide in 2007 were, therefore, $78,528,093.

In the earlier study by Gillett and Lightfoot (2001), there was considerable secrecy concerning levels of access fee payment, even at the aggregate national level. Much of the data on access fee payment was estimated with considerable difficulty. For the present study, information on access fee receipts was available in the public domain for most countries. Where this was not the situation, fisheries and/or finance officials cooperated to furnish the information.

Other Government Revenue from Fisheries

In each country chapter, information is provided on the readily available information related to government revenue generated from the fisheries sector that is not from foreign fishing access fees. That information is summarized in Table 26.10.

Table 26.10: Government Revenue from Fisheries Other than Foreign Access Fees

Country	Government Fishery Revenue
Cook Islands	The fees received for licensing the domestic offshore fleet were: FY2006, NZ$95,000; FY20007, NZ$110,000; and FY2008, NZ$220,000.
Federated States of Micronesia	The national annual reports do not provide information on government revenue other than fishing access fees. Any licensing of small-scale fishing would occur at the state level.
Fiji Islands	In 2006, F$957,660 was paid by the locally based offshore fishing fleet for access fees, management fees, and other license fees. F$48,650 was paid by participants in coastal fisheries for various fees and permits.
Kiribati	There are transshipment fees (A$253,652 in 2006), tourist fishing licenses, observer fees (A$7768 in 2006), and marine product export license fees.
Marshall Islands	In 2007, the transshipment fees collected were $105,600. Other fees and charges were $130,952.
Nauru	Disaggregated information is not available on government revenue from fisheries other than that associated with access by foreign fishing vessels.
Niue	No information is available on the amount of such revenue, if any.
Palau	A significant source of direct government revenue from fisheries activities is the fish export tax. Unpublished data from the Bureau of Budget and Planning shows the total amounts collected from the fish export tax: FY2005, $882,000; FY2006, $1,471,000; and FY2007, $1,002,000.
Papua New Guinea	Domestic license fees received by the National Fisheries Authority were K1.4 million in 2007 and “other fees” K8 million in 2005 (data for later years not available).
Samoa	ST105,000 was collected in FY2008 for domestic fishing vessel licenses.
Solomon Islands	The government receives substantial revenue from the fisheries sector. The sources include licensing of domestic vessels, fish export taxes, and transshipment fees. Domestic tuna vessel license fees in 2008 paid by National Fisheries Development Ltd. and Soltai were SI$100,000 and SI$8,000, respectively.

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Table 26.10: continuation

Country	Government Fishery Revenue
Tonga	The T$180,074 collected for "Revenue Performance" consisted of Consumption Tax, Sundry Revenue – Vava'u, Sundry Revenue – Ha'apai, Sundry Revenue – Niua Toputapu, Market Fees, Sundry Revenue, Sales of Products and Produces, Sundry Revenue, and Miscellaneous Licenses. Sale of products includes aquaculture items and posters.
Tuvalu	No information is available on the amount of nonaccess revenue, if any. Vessels rarely transship in Funafuti. There are no licensing requirements or export levies on domestic fishing vessels.
Vanuatu	The Fisheries Department annual report of 2007 (Fisheries Department 2008a) lists various sources of revenue. Apart from the access fees, the other sources are "other disposal" (Vt220,404 collected in 2007), "total repair fees" (Vt1,118,855), "total permits recoveries" (Vt1,707,905), and "other items revenue" (Vt1,360). The total of this nonaccess revenue was Vt3,048,524 in 2007.
American Samoa	Information on other forms of government revenue from the fisheries sector, if any, is not readily available.
French Polynesia	In general, the fisheries sector is not revenue generating, but rather subsidy absorbing.
Guam	Any fishing licensing fees paid by vessels based in Guam go to US government agencies, not to the Government of Guam.
New Caledonia	There are both subsidies and taxes applied to commercial fishing activity, but this information is not readily available.
Northern Mariana Islands	Any fishing licensing fees paid by vessels go to US government agencies, not to the Government of Northern Mariana Islands.
Pitcairn Islands	Apart from fees for foreign fishing access, no information is available on government revenue from the fisheries sector.
Tokelau	Apart from fees for foreign fishing access, no information is available on government revenue from the fisheries sector.

A$ = Australian dollar, F$ = Fiji dollar, FY = fiscal year, K = kina, NZ$ = New Zealand dollar, SI$ = Solomon Islands dollar, ST = tala, T$ = pa'anga, Vt = vatu.

Source: Country chapters of this report.

The data in Table 26.10 form a heterogeneous mixture, reported with varying degrees of rigor, and not easily comparable across the countries. The listed items are really monies collected by government and are a combination of substantial government revenue items (e.g., domestic license fees), cost recovery for a service provided (e.g., CITES inspection permit), and payments for commercial activities of government fisheries agencies (e.g., money paid by exporters for giant clams raised by a fisheries division).

Domestic fishing license fees are one of the most important types of nonaccess revenue from the fisheries sector in the region. Five countries (Cook Islands, Fiji Islands, PNG, Samoa, and Solomon Islands) have significant domestic fishing license fees and they make information on those fees readily available. All these examples are at least partially applicable to locally based offshore fishing and most of these are intended to procure for the government a portion of the resource rent in that fishery.

Fees for transshipment are only given in Table 26.10 for three countries, but it is likely that with additional research, the amount of money paid in each country could eventually be obtained—but this highlights an important issue in fishery benefits of the region: the sector is not active in most countries at advertising its importance. In the tourism sector, it is likely that a benefit of the magnitude of that from transshipping would be publicized with enthusiasm. Some idea of the benefits of transshipping in the region is stressed by McCoy (2007):

> "It has been estimated that, on average, a port call by a transhipping purse seiner results in about $3,000–$6,000 in direct revenue to the hosting country, including per tonne transshipment fees charged in some countries….During the period 2004–2006 in-port purse seine transshipment took place approximately 2,700 times in 14 ports of Pacific island countries. The bulk of the activity during that three-year period took place in Pohnpei (889 transhipments), Majuro (524), Rabaul (381), Honiara (279), and Tarawa (187)."[2]

Some of the additional features of the nonaccess government revenue from the fisheries sector are:

- Substantial revenue from the fisheries sector presumably comes from personal and company taxation—but it appears that this information has not been compiled in any country in the region (as has been done for tourism).
- Apart from any company/personal taxation, no Pacific island dependent territory obtains significant nonaccess revenue and only Tokelau received access revenue.
- Two countries have export duties on fishery products, which apparently were imposed to prevent unfair transfer pricing by vertically integrated fishing/marketing companies.

[2] These transhipment statistics do not include the large amount of longline transhipping by vessels from the People's Republic of China, Japan, Republic of Korea, Taipei,China, and other countries.

- In general, semiautonomous fisheries authorities (e.g., PNG's National Fisheries Authority, the Marshall Islands Marine Resources Authority) seem to be better at reporting on government revenue, including nonaccess revenue.

In terms of both good governance and giving due credit to the fisheries sector for any revenue generated, it would be sensible to track the significant revenue generated and make the results readily available to fishery stakeholders. Dedicating a small section in the annual report of a government fisheries agency, such as that done by the Fisheries Department in Fiji Islands, would be relatively easy and could institutionalize the process.

Employment Related to Fisheries

Country Information

In each of the country chapters of this report, information on fisheries employment[3] is provided. Although several different types of employment data are presented, the objective of this section is primarily to gain an appreciation of the importance of employment in fisheries at the national level relative to other occupations. In addition, this section examines the distribution of this involvement with respect to gender and attempts to make some intercountry comparisons. Although the theme of this study revolves around analyzing benefits (including those from employment) that flow from fisheries, it is appropriate to present some ideas on the types of employment information that would be important for fisheries management. This touches on the subject of why employment information is collected.

The employment information presented in the country chapters is a heterogeneous assemblage of various types of data. Meaningful summaries at the national level and intercountry comparisons are difficult for a number of reasons:

- The data originate from informal estimates to studies that range from initiatives confined to the fisheries sector to much broader exercises that covered all economic sectors or the entire population.

[3] In this section, employment and participation are used almost synonymously, but there is a tendency to use employment for wage work and participation for subsistence activities.

- The studies deal, in different ways, with the various mixes of paid work, unpaid work, and work for the family.
- There is inconsistency across countries in the categorization of fish processing. In some countries, it is placed in the same sector as fishing, while in others, it is in manufacturing.
- Some studies have produced obviously erroneous results; others have problems of credibility.
- Some information is collected by specific interest groups and thus could be selective and/or self-serving.

Table 26.11 gives for each country of the region survey data believed to be the best indication of the relative importance of (a) employment in commercial fisheries, and (b) involvement in subsistence fishing.

Table 26.11: Relative Importance of Fisheries Employment—Commercial and Subsistence

Country	Fishery Employment and/or Participation Information
Cook Islands	Of the employed population recorded in the 2001 census (5,928 people), 427 (7.2%) indicated they were employed in "agriculture and fishing," 183 of them on Rarotonga. For subsistence fishing, the employment situation was very different between Rarotonga and the outer islands. A more recent survey on Mangaia Island indicated that almost all households (92%) were engaged in fisheries with an average of 1–2 fishers per household. A similar survey on Rarotonga showed that less than half of all households (44%) were engaged in fisheries, with an average of one fisher per every second household only.
Federated States of Micronesia	In FY2007, a survey showed that fisheries accounted for 1.3% of all employed people, but was oriented to formal employment with the larger fishing companies. Little national-level information is available on participation in small-scale fisheries.
Fiji Islands	Based on information in a study in late 2004 and the 2004/05 Fiji Islands employment study, the estimated 9,144 fisheries jobs in the 12 fisheries subsectors (e.g., offshore, processing) represent about 3.8% of the total number of jobs in Fiji Islands (wage, salaried, self-employed). There is little national-level information available on participation in subsistence fisheries.
Kiribati	The 2005 Kiribati census indicated that 7.1% of "cash workers" were in "agriculture/fishing." The results of a census in 2000 had greater detail for fisheries employment: "Fisheries" was the main activity for 1.5% of people. With respect to subsistence fisheries, the results of fishery-focused surveys by the Fisheries Division are mostly narrow in scope (i.e., one company, one island, one subsector of fisheries) and it is difficult to draw national conclusions.

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Table 26.11: continuation

Country	Fishery Employment and/or Participation Information
Marshall Islands	In early 2008, an employment survey showed that "fishing" accounted for 2.8% of the total number of jobs in the country and 4.7% of the income from jobs. A 2004 survey estimated that 62.2% of households on Majuro did at least some fishing once a year. Little national-level information is available on participation in subsistence fisheries.
Nauru	A survey in 2005 indicated that fisheries do not play a significant role in income for households. For 5%, it was their first income and for 17%, their second income. A total of 245 households were surveyed for income and expenditure, with 97% of them found to be engaged in fishing activities.
Niue	The 2002 HIES indicated that "fish income" represented 0.9% of all income in Niue for the year and that 12% of all households had some "fish income." There were 293 boats on the island in 2006 when the population was 1,626, or one boat for 5.5 people.
Palau	The 2005 census stated that (i) of the 13,800 people reporting income in 2004, 305 (2.2%) reported income from selling fish and (ii) of 14,154 people over 18 years old in 2004, 933 (6.6%) reported some subsistence fishing activity.
Papua New Guinea	A 2008 study estimated 8,990 jobs associated with large-scale tuna fishing and canning. Considering the "monetary employment" of 774,000 in PNG in 2008, these 8,990 tuna jobs represented about 1.2% of the monetary jobs in the country. A 2005 study estimated about 2,000–4,000 part-time artisanal fishers. A 2001 study indicated that 250,000–500,000 persons participated in the coastal subsistence fishery. Participation in freshwater fishing is very large: 23% of all rural households in the country were engaged in catching fish (both marine and freshwater fishing).
Samoa	Formal registered employment in 2007 consisted of 22,150 people, of which 196 (0.9%) were in the fishing sector. With respect to small-scale fisheries, a Fisheries Division report in 2007 indicated that although only 7.26% of the population consisted of fishers, 41.7% of households had at least one fisher.
Solomon Islands	A study in 2005 indicated a total of 42,297 formal jobs in the country in 2004, of which 5,114 (12.1%) were in fisheries. For small-scale fisheries, a study in 2006 found that 50% of females and 90% of males participated in fishing activities; 83% of households engaged in some form of fishing activity.
Tonga	The 2003 survey of employment indicated that there were 34,561 people employed, of whom 1,050 (3%) were employed in the category of "fishing." With respect to participation in small-scale fishing, a 2003 Australian-sponsored study estimated the "number of fishers": Tongatapu, 6,470; Ha'apai, 2,053; Vava'u, 4,375, or a total of 12,898, which is 12.8% of the country's population in 2003.

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Table 26.11: continuation

Country	Fishery Employment and/or Participation Information
Tuvalu	The 2002 Population and Housing Census of Tuvalu indicated that 58% of all people participated in fishing during the week before the census, of which 80% was only for "own/family use," 2% for sale only, and 18% for mixed subsistence/commercial.
Vanuatu	There is not much readily available national-level information on employment in the urban-based commercial fishing, aquaculture, and postharvest activities. A 2007 agriculture census indicated that (i) 72% of the rural households in Vanuatu possessed fishing gear and engaged in fishing activities during the previous 12 months; (ii) the number of fishing households was 15,758; and (iii) of the fishing households, 11,577 (73%) fished mainly for home consumption, 4,127 (26%) for home consumption with occasional selling, and 74 (less than 1%) mainly for sale.
American Samoa	A government survey in 2006 showed 5,894 government workers, 4,757 cannery workers, and 6,744 employees in the private sector. The canneries, therefore, provided 27% of all employment. There were 153 commercial fishers involved in domestic fishing. Data on involvement in subsistence fishing are not readily available.
French Polynesia	In 2007, 13 people were involved in non-pearl aquaculture, 7,000 in pearl culture, 1,800 in coastal fishing, 1,025 in offshore fishing, and 200 in freshwater fishing, or a total of about 17,500. For the relative importance of this involvement: (i) the total population of French Polynesia in 2007 was 259,800, and (ii) there were 68,849 "declared" jobs in the economy.
Guam	A study in 2008 stated that the Guam Fishermen's Cooperative membership included 164 full-time and part-time fishers (0.1% of Guam's population) and it processed and marketed an estimated 80% of the local commercial catch. On subsistence fishing, a 2007 household survey of 400 local residents showed that approximately 40% of them fished on a regular basis, which was identified to be more important as a social activity than as an income-generating activity.
New Caledonia	About 1,000 people are employed in commercial fishing/ aquaculture, which represents about 1.2% of the 80,685 economically active people in the territory. With respect to noncommercial fishing, a study in 2000 indicated that of 1,000 people interviewed in the three provinces of New Caledonia, 50% of the respondents fished 1–3 times per week.
Northern Mariana Islands	The 2000 census and the 2005 HIES gave the number of employed at 614 and 894 persons, respectively. The data, however, were disaggregated only to the level of "people employed in farming, fishing, and forestry." A survey in 2006 found that 20% of all the people interviewed were active fishers and went fishing once every week or two.

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Table 26.11: continuation

Country	Fishery Employment and/or Participation Information
Pitcairn Islands	In 1994, an SPC officer observed that there were 8–9 "hard-core fishers" on the island, with another 3–4 who also fish fairly regularly. Twelve people equate to about 19% of the island's population.
Tokelau	In 2003, a survey of 153 households on all three atolls determined that 152 households (99.3%) were involved in fishing.
Wallis and Futuna	A fisheries inventory of Wallis and Futuna in 2001 showed that of the 333 fishers identified on Wallis, 26% fished only once per week, 54% twice per week, and 20% three or more times per week. Of the 46 fishers on Futuna, only 10 fished often enough to be considered "artisanal fishers."

FY = fiscal year, HIES = household income and expenditure survey.

Source: Employment sections of the country chapters of this report.

Some noteworthy features on fisheries employment in the above table are:

- The importance of participation in subsistence fisheries seems to have a strong relationship to the type of island—highest in atolls, followed by small islands, and least in large high islands. This pattern is somewhat altered by PNG with its significant freshwater subsistence fisheries.
- The importance of fisheries in formal employment seems to be related more to business conditions than to island type. These conditions include, among others, the tax situation, proximity to processing facilities, and airline connections to fresh fish markets.
- In about half the countries, there is sufficient information to gain an appreciation of participation in commercial fishing relative to participation in subsistence fishing. With one exception (Palau), involvement in subsistence fishing is vastly greater. Typically, 10–20 times more people fish for subsistence than for commercial purposes.
- Large-scale tuna processing (American Samoa, Fiji Islands, PNG, Marshall Islands, and Solomon Islands) has a remarkable effect on a country's fisheries-related employment—where it is captured by surveys.
- Most formal employment in fisheries appears to be tuna-related.

- Participation in mixed subsistence/commercial fishing is significant in survey results from Vanuatu, Tuvalu, Nauru, and Niue, but is likely to be important in several other countries also.

However, there is considerable subjectivity involved in deciding what is an "important" level for fisheries employment. In one survey (COFISH 2005) for Nauru, it was stated that "fisheries do not play a significant role in income for households—for 5% it is their first income and for 17% their second income." There seems to be at least some justification for calling an activity "significant" that produces some income for nearly a quarter of the households in a country.

Also, general business surveys and surveys based on tax or provident fund records appear to be especially inappropriate for the fisheries sector because commercial fisheries in most Pacific island countries include large firms as well as tiny businesses, the latter often in isolated areas. Such surveys are carried out in about half of the countries in the region and they typically get responses from the larger firms, which are then assumed to portray the entire sector. This difficulty appears to be worse in fisheries than in other economic sectors.

A surprisingly large number of studies that touch on fisheries employment do not define the terms used (e.g., work, participation, employment). When definitions are different in the various countries, they create great difficulties for intercountry comparisons. In Samoa, one survey defines employment in an industry as those people who make national provident fund contributions, whereas in Tonga, employment in an industry is defined by the government statistics agency as working at least one hour a week in that industry.

PNG, with 68% of the total population in the region, has a massive effect on any regional aggregation of participation in fishing. However, little is known about its small-scale fisheries employment. The range in estimates for participation in the coastal subsistence fisheries in PNG ("between 250,000 and 500,000" in one often-quoted study) approaches the magnitude of such participation in all the other countries of the region combined.

In reviewing the interface between employment surveys and the fisheries sector, one of the most significant observations that can be made is that one cannot rely on government statistics offices to know what fisheries employment information to collect and how to collect it. Considerable knowledge of the sector is required to collect meaningful information. Government fisheries officials and fishing industry participants have an important role to play in working with statistics agencies to define terms and categories, formulate survey strategies, and scrutinize survey results.

Participation of Women in Fisheries

Due to national and regional efforts over the past 15 years, much is now known about women's fishery activities in the Pacific islands. Special efforts were made during the present study to obtain quantitative information on this aspect, summarized in Table 26.12.

Table 26.12: Male and Female Participation in Fisheries

Country	Summary of National Qualitative Data
Cook Islands	Not much gender-disaggregated national information is readily available on participation in fisheries.
Federated States of Micronesia	Quantifying gender participation in fisheries appears to have received limited attention. In 2000 and 2001, a baseline survey was conducted assessing the role of women in the fisheries sector. Although some valuable ideas were put forward, little quantitative information was produced on the participation of women in fisheries.
Fiji Islands	Combining information in a 2008 study of gender issues in the Fiji Islands tuna industry with the 2004/05 Fiji Islands' employment study, the jobs held by females in Fiji Islands tuna industry represented about 1.0% of the total number of jobs held by females in Fiji Islands. There is considerable gender-specific information on employment in the Fiji Islands' tuna industry, but much less so in the wider fisheries sector.
Kiribati	Not much gender-disaggregated national information is readily available on participation in fisheries.
Marshall Islands	Not much gender-disaggregated national information is readily available on participation in fisheries.
Nauru	A survey in 2005 estimated that the total number of fishers in Nauru was 4,451, made up of 2,972 men and 1,579 women.
Niue	There is no information documenting the activities of women involved in fisheries.
Palau	The 2005 census estimated that of the 933 subsistence fishers 186 (19.9%) were female.
Papua New Guinea	A 1995 study estimated that women caught at least 25% of the subsistence catch, or more if the crab catch were added. A 2008 study on gender in the tuna industry indicated that about 7,000 women worked in the PNG tuna industry, including onshore handling and loining or canning, and technical and administrative positions. The study concluded that the tuna industry employed 3.3% of all formally employed women in the country.

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Table 26.12: continuation

Country	Summary of National Qualitative Data
Samoa	Of the people formally employed in fishing in 2007, 11.7% were female. For small-scale fishing, a study in 2001 indicated that approximately 18% of all village fishers were female. These women contributed around 23 % of the total weight of seafood.
Solomon Islands	About 90% of the 750 employees of the tuna cannery were women in 2008. A 2006 poverty assessment found that 50% of females and 90% of males participated in fishing activities.
Tonga	The 2001 agriculture census showed that 7,704 persons were engaged in the fishing activities during the week prior to the census, 21% of whom were female. The 2003 survey of employment in the country indicated that there were 34,561 people employed in Tonga, of whom 1,050 (3%) were employed in the category of "fishing." Of those employed in fishing, 180 (17%) were female.
Tuvalu	The 2002 Population and Housing Census of Tuvalu indicated that of the 528 people whose main economic activity was fishing, 68 (12.9%) were female.
Vanuatu	Not much gender-disaggregated national information is readily available on participation in fisheries.
American Samoa	Not much gender-disaggregated national information is readily available on participation in fisheries.
French Polynesia	Not much gender-disaggregated national information is readily available on participation in fisheries.
Guam	Not much gender-disaggregated national information is readily available on participation in fisheries.
New Caledonia	Not much gender-disaggregated national information is readily available on participation in fisheries.
Northern Mariana Islands	Not much gender-disaggregated national information is readily available on participation in fisheries.
Pitcairn Islands	In 1994, an observation was that women and men fished regularly from the rocks, mainly for the evening meal.
Tokelau	A 1998 survey found that the average household spent 14 person hours per week fishing, with women spending an average of 2 hours, and men 12 hours. In 2003, a study found that females were involved in some inshore fishing methods, although males still dominated. Females accounted for just over 50% of the reef gleaning effort, and around 40% of diving effort, with most of the diving effort directed at harvesting clams.
Wallis and Futuna	Men go fishing, but it is mainly the women who provide the daily seafood. The island of Wallis is relatively flat compared to Futuna and gardens do not have to be made in difficult terrain so far from the villages. The women of Wallis are not involved in fishing in the same way as the Futunan women.

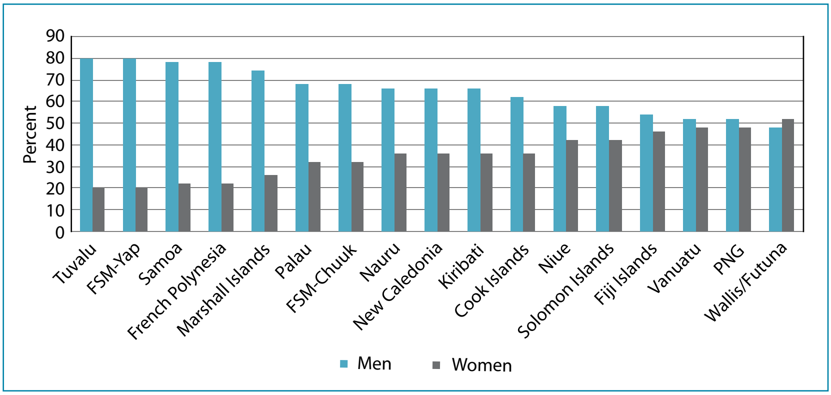
Source: Employment sections of the country chapters of this report.

For most of the independent Pacific island countries there is at least some quantitative information at the national level on participation in fisheries by sex. For the territories, such information is readily available only for Tokelau.

A close scrutiny of the surveys upon which the estimates in Table 26.12 are based (see country chapters for details) shows that the accurate portrayal of the importance of women in fisheries employment appears to be negatively affected by two factors: (i) the concept of using "main unpaid activity" in surveys for defining the subsistence fisheries sector, which downplays the importance of secondary activities (e.g., even for women who do considerable fishing, childcare is often the main unpaid activity); and (ii) placing commercial fish processing in some countries (where many women are employed) in the manufacturing sector.

The relative participation in village fishing by sex for all types of fishing activities combined, from the preliminary results of a multidisciplinary regionwide fisheries survey (SPC 2008b) in which 4–6 sites were surveyed in 17 countries or island groups, is given in Figure 26.9. It is concluded that there is a general dominance of fishing at the village level by men. The opposite is true for invertebrate fishing, still a domain of women.

Figure 26.9: Proportion of Men and Women Participating in Fishing



FSM = Federated States of Micronesia, PNG = Papua New Guinea.

Source: SPC (2008b).

Regional Employment Studies

Fishery subsectors for which estimates of regional employment are available are:

- **Aquaculture.** "Aquaculture may contribute some form of full-time or partial employment for around 25,000 people in the region" (SPC 2008b).
- **Foreign Fishing Vessels.** "There are about 1,200 men from the region working on the 10 major fleets. The major employers are Japan (about 30% of employment), [Republic of] Korea (24%), [the] United States (15%), and [Taipei,China] (13%)" (Gillett and McCoy 1997).
- **Trochus Processing.** "The 14 operational trochus factories in the Pacific islands employ 213 workers" (World Bank 1997).
- **Large- and Small-scale Commercial Fishing.** Using estimates of vessel numbers, "about 45,000 Pacific islanders appear to be presently involved in commercial fishing in the region" (Gillett and Lightfoot 2001).

Table 26.13: Tuna Employment in Pacific Island Countries

Country	Local Jobs on Vessels			Local Jobs in Shore Facilities		
	2002[a]	2006[b]	2008[c]	2002[a]	2006[b]	2008[c]
Cook Islands	50	15	12	15	15	10
Fiji Islands	893	330	150	1,496	2,200	1,250
Federated States of Micronesia	89	36	25	131	24	140
Kiribati	39	15	15	47	80	70
Marshall Islands	5	0	25	457	100	116
Nauru	5	0	0	10	2	0
Niue	5	0	0	0	14	18
Palau	1	0	0	11	5	20
Papua New Guinea	460	110	440	2,707	4,000	8,550
Samoa	674	110	255	108	90	40
Solomon Islands	464	66	107	422	330	827
Tokelau	0	0	0	0	0	0
Tonga	161	75	45	85	35	35
Tuvalu	59	20	65	36	10	10
Vanuatu	54	20	30	30	30	30
Total	**2,959**	**797**	**1,169**	**5,555**	**6,935**	**11,116**

Note: The new Majuro loining plant began operation after the period covered by the 2008 survey.
Sources: [a] Gillett (2002), [b] DevFish (2007), [c] Gillett (2008).

As mentioned above, most formal fisheries employment in the region is associated with tuna. Employment related to tuna in Pacific island countries in 2002, 2006, and 2008 is shown in Table 26.13.

Given the amount of effort that regional organizations have exerted on individual fishery subsectors across the region, it is surprising that more work has not been done on estimating the associated employment—especially considering that unemployment is arguably one of the most serious long-term problems of the region. There appear to be no readily available data on total regional employment in such activities as marine aquarium industry, live reef food fish trade, domestic fish marketing, bêche de mer diving/processing, and commercial sportsfishing.

With respect to estimating regional employment in fishery subsectors, any estimate, however crude, may have considerable value, if only to encourage refinement of the employment estimates. In this regard, SPC's efforts to estimate aquaculture employment in the region are commendable. However, some degree of standardization in terminology and units of measurement is needed. It is not very meaningful to compare the number of "full-time equivalents jobs" in one study with the number of people having "full-time or partial employment" in another study.

Employment Information and Fisheries Management

Information on fisheries employment is critically important not only for estimation of benefits to the countries concerned but also for fisheries management. In the many trade-offs that fisheries management entails, it is important to know how many people will be affected, positively or negatively, by management decisions. With the possible exception of employment related to tuna (fishing/processing), few data are available for employment by fishery in any of the countries of the region.

As an example, there has been a debate in Fiji Islands stretching over at least 2 decades involving the trochus trade. The management issue is whether to ban the export of unprocessed trochus (and encourage processing and associated employment in Suva), or to allow unprocessed exports (which results in a higher price to rural fishers). The precise number of people working at the trochus processing plants is known, but much of the debate over allowing raw trochus exports revolved around the number of trochus collectors—for which no estimates have ever been made.

Similar debates over the number of people to be affected by fisheries management decisions have occurred in other fisheries of the region, including bêche de mer (Solomon Islands), spearfishing (Fiji Islands), night scuba diving (American Samoa), giant clams (Tonga), and export of reef fish (Palau).

The message is that the availability of fisheries employment information by fishery could improve fisheries management decisions. Other disaggregations that would be useful to fisheries management are by sex, by urban/rural resident, and by local/expatriate. A ban on relatively high technology (e.g., use of scuba gear) would favor rural fishers. The use of Asian versus local crews on locally based tuna vessels is a topical fisheries management issue in several countries of the region.

Fish Consumption

This section presents selected information on per capita fish consumption in the region and some notable features encountered while obtaining and analyzing this information. Some objectives of collecting fish consumption information are given and some simple suggestions for improvement are offered.

Per Capita Fish Consumption

The readily available information on the consumption of fish and other fishery resources is given in the country chapters. For most countries, there have not been any dedicated national-level studies of fish consumption in the last decade. The Gillett and Lightfoot study (2001) compiled ranges in national fish consumption as determined by various studies in the 1990s (Table 26.14).

The table shows some significant patterns. In general, countries comprising small islands have high fish consumption, while large island countries have low consumption. Exceptions are Tonga, where the studies suggest surprisingly low fish consumption, and Palau, where fish consumption is remarkably high.

In general, the per capita consumption figures in Table 26.14 show that most Pacific island countries exceed by a large margin the world average per capita fishery product consumption rate of 16.5 kg (Vannuccini 2005).

Based on the predicted age structure of populations in the Pacific until 2030, the age–weight relationships typical of the region and the fresh fish content of about 20% protein suggest that an annual average per capita fish consumption of 34–37 kg provides about 50% of the recommended protein intake for Pacific island countries (Bell et al. 2009).

Table 26.14: Ranges of Estimated Annual Per Capita Fishery Product Consumption

Country	Range of Estimates (kg/person/year)
Cook Islands	47.0–71.0
Fiji Islands	44.0–62.0
Federated States of Micronesia	72.0–114.0
Kiribati	72.0–207.0
Marshall Islands	38.9–59.0
Nauru	46.7
Niue	49.0–118.9
Palau	84.0–135.0
Papua New Guinea	18.2–24.9
Samoa	46.3–71.0
Solomon Islands	32.2–32.7
Tonga	25.2–30.0
Tuvalu	85.0–146.0
Vanuatu	15.9–25.7

Source: Gillett and Lightfoot (2001).

Comparing Fish Consumption Estimates

On a more detailed level, comparisons between fish consumption surveys and between countries may be inappropriate, or even wrong, due to methodological differences. The main difficulty is that most studies on fish consumption in the region determine one of two kinds of consumption: either the amount of food actually ingested or the whole weight of the fish that produces the food (known as whole weight [or live weight] equivalent). These two measurements are quite different. Problems set in when a study using one measurement is compared directly (without any correction) to other studies using the other method, or (most frequently) when the comparisons involve studies in which the methods are unknown. The situation portrayed in Box 26.1 occurs quite frequently.

Box 26.1: Fishy Comparisons

During the present study, there was one Pacific island country in which a fish consumption study in 1998 (unknown methodology) was directly compared with a study in 2001 (used a mixture of food weight and whole fish equivalent) and with another in 2006 (that used food weight). Changes in per capita consumption between the surveys were calculated and attributed to specific factors (i.e., ciguatera, fisheries management measures).

Source: Consultant's observation.

Other difficulties in comparing fish consumption surveys include

- food items being compared—whether just finfish, or all aquatic animals or even aquatic plants, are included. The term "seafood" is sometimes used, but this creates uncertainty in countries with a large production from freshwater fisheries;
- canned fish—whether this is included and whether the quantity (all edible) is being compared to whole fish equivalents (not all edible);
- fish imports and exports—(i) whether these are included, (ii) how they are included in countries that have unreliable export statistics, and (iii) determining from the statistics whether imports consist of whole fish or just the edible parts; and
- tourists—whether the tourist population is included and whether there is any correction for differential consumption by tourists.

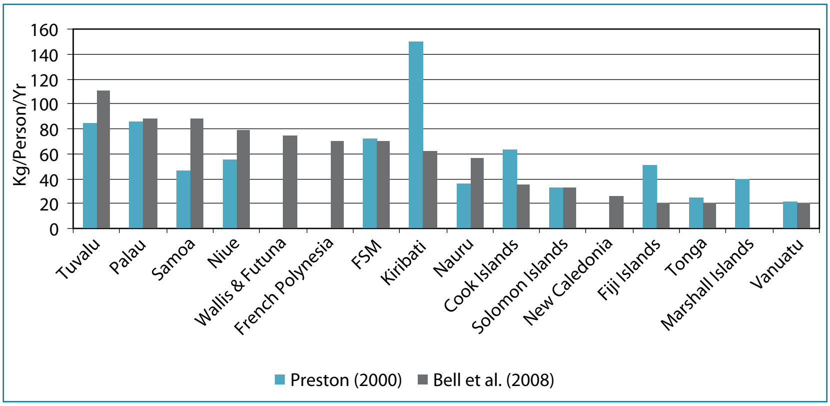
In view of the above difficulties, there is considerable justification for avoiding comparison of fish consumption surveys unless the methods used by the studies are known and they are either the same or corrected so that equal features are being compared.

Thus, caution is advised when considering the results of the comparisons in the table above, which involved all available studies of per capita fish consumption in those countries. Similarly, for the present study it would not be appropriate to compare the many incongruous fish consumption studies encountered in the countries covered.

As an alternative, two regional studies that used a consistent methodology across the region to estimate national fish consumption are compared here. The first (Preston 2000) used estimates of fish production, imports, exports, and population to estimate per capita fish consumption expressed as whole weight equivalent. The second (Bell et al. 2009) used information from HIES conducted between 2001 and 2006 to estimate per capita fish consumption expressed as whole weight equivalent. The Preston (2000) study did not include the territories of PNG, while the Bell et al. (2009) study did not have comparable HIES data for PNG or the US territories.

The two studies gave similar consumption levels in five countries (Palau, FSM, Solomon Islands, Tonga, and Vanuatu), while the Bell et al. study gave significantly higher per capita consumption in four countries (Tuvalu, Samoa, Niue, and Nauru) and significantly lower per capita consumption in three countries (Kiribati, Cook Islands, and Fiji Islands) (Figure 26.10).

Figure 26.10: Fish Consumption as Estimated by Two Studies



FSM = Federated States of Micronesia.
Sources: Preston (2000) and Bell et al. (2009).

No reasons are apparent for the three groupings (similar, high, low) in Figure 26.10. It should be noted that the Bell et al. estimate for per capita fish consumption in Kiribati (62.2 kg) is lower than those in many other studies.

Country Issues

Some of the important issues in per capita fish consumption of each country and its measurement are given in Table 26.15.

Common features that emerge from the country information include

- uncertainty over what is being measured: food ingested versus whole fish equivalent;
- need to reconcile the results of HIES and fishery-focused surveys;

- presence of a tourist population, which adds to the complexity of determining per capita fish consumption; and
- importance of fish from industrial tuna operations in fish consumption.

Table 26.15: Some Features of Fish Consumption in the Countries of the Region

Country	Features and Issues
Cook Islands	Many of the recent studies of fish consumption have been confined to Rarotonga. The major change in fish consumption in Rarotonga in the last decade is the availability of fish from longliners. Outbreaks of ciguatera on Rarotonga may have reduced fish consumption. The presence of a relatively large tourist population increases the complexity of determining per capita fish consumption.
Federated States of Micronesia	A recent detailed review of the nutritional literature has no mention of per capita fish consumption. Bycatch from longline fleets and discards from seiner transshipment are important sources of food.
Fiji Islands	Local sales of the catch from locally based offshore fishing are having a major impact on per capita fish consumption in the Suva area. One of the major objectives of tilapia farming was to increase fish consumption in noncoastal areas, but no assessment of the impact has been carried out. The results of the 2004 Fiji Islands National Nutrition Survey do not provide much insight on the level of seafood consumption, but rather the frequency of consumption.
Kiribati	Many studies of fish consumption indicate that Kiribati has the highest rate of fish consumption of any country in the world. Several studies of the Kiribati section of this report do not use the same methodology, or do not specify the methodology, for determining fish consumption.
Marshall Islands	There have been no general nutrition surveys in the last decade that involve fish consumption. Information on fish consumption comes from older general nutrition surveys or new studies focused on the fisheries sector. Most of the latter have been focused on Majuro.
Nauru	Several studies state that the consumption of fishery products has changed considerably in the last decade. A recent study indicates that food security has emerged as a serious issue, with men, women, and children foraging on reefs and hunting birds daily for food, and families resorting to extended family systems to barter wild food for imported food items.
Niue	The three fish consumption studies cited in this report gave annual per capita consumption (whole weight equivalent) amounts that were very different: 49.0 kg, 118.9 kg, and 79.3 kg.

continued on next page

Table 26.15: continuation

Country	Features and Issues
Palau	There is a very large difference in per capita fish consumption between the various estimates. Determining consumption is made complex by the tourist population, a local longline fleet, and seafood imports.
Papua New Guinea	Most documents and reports on nutrition focus on agriculture and animal husbandry, and pay little attention to fish. Both fresh fish and canned fish are important, with most of the latter being produced domestically (unlike in most countries of the region). Difficulties of measuring the production of small-scale fisheries hamper efforts to determine fish consumption and there are no new HIES data.
Samoa	The HIES and a fisheries survey (both reported to be of high quality) have estimated per capita fish consumption: 87.4 kg (HIES) and 71 kg (fishery survey). The contribution to food supply of the locally based offshore fleet has been variable over the last 15 years.
Solomon Islands	The HIES and a fisheries survey gave similar results for annual per capita fish consumption—about 33 kg. Tuna canned in the country and discarded fish from tuna transshipment operations are significant sources of food, but the latter tends to periodically displace coastal commercial fishers.
Tonga	Annual per capita consumption based on dividing the subsistence and locally marketed fishery coastal production by the Tongan population is about 58 kg per capita, substantially more than most recent estimates. A relatively low consumption of fish is likely to be caused by the availability of cheap fatty imported meats. The amount of bycatch and nonexported fish from offshore locally based vessels is large.
Tuvalu	A recent policy report states that estimates of per capita fish consumption vary from island to island, but are in the range of 100–200 kg/year.
Vanuatu	The HIES and a fisheries survey gave similar results for capita fish consumption: 20.3 kg (HIES) and 21.0 kg (fishery survey).
American Samoa	Most estimates of fish consumption in American Samoa show low levels, usually the lowest of any Pacific island country.
French Polynesia	There is a large range in the various studies of per capita fish consumption, which could be related to measuring different types of consumption (food vs. whole weight). A large amount of high-quality seafood is imported. The presence of a relatively large tourist population increases the complexity of determining per capita fish consumption.
Guam	Annual seafood consumption is very low.
New Caledonia	The HIES and a fisheries survey gave similar results for capita fish consumption: 25.6 kg (HIES) and 21.6 kg (fishery survey). A large amount of high-quality seafood is imported.

continued on next page

Table 26.15: continuation

Country	Features and Issues
Northern Mariana Islands	Estimating the per capita fishery product consumption is complicated by large amount of canned and noncanned seafood imports, the presence of a large tourist population, and a subsistence fishery that is not covered by the 2005 HIES nor covered explicitly by current fishery monitoring programs.
Pitcairn Islands	The annual per capita fish consumption (whole fish equivalent) is about 148 kg, but with the small population, it would vary with the number of adults on the island.
Tokelau	Most fishery-focused estimates of fish consumption indicate over 100 kg per person per year. There are no HIES estimates of fish consumption.
Wallis and Futuna	The HIES and a fisheries survey gave somewhat similar results for capita fish consumption: 74.6 kg (HIES) and 66.9 kg (fishery survey).

HIES = household income and expenditure survey, kg = kilogram.

Source: Country chapters of this report.

Contributions of Tuna and Aquaculture to Per Capita Fish Supply

The importance of fish from industrial tuna fishing operations in fish consumption in several countries of the region is highlighted above. The main types of such fishing are longlining and purse seining.

The impact of bycatch from locally based longline fleets on fish consumption appears to be quite large. For example, as noted in the chapter on Fiji Islands, the amount of domestically marketed catch from locally based offshore vessels suggests an annual supply of fish to Suva residents from the local offshore fleet of 10.4 kg per capita. In Tonga, the amount of bycatch and nonexported fish from offshore locally based vessels is about the same—about 10.7 kg per capita per year for the population of Tongatapu.

Total catch (tuna plus bycatch) of the locally based offshore fleet in the Pacific islands was about 44,000 t in 2007 (country chapters of this report). Assuming that 10% of this fish was marketed locally, this amounted to 4,400 t in the entire region.

Domestically available fish from industrial tuna operations is likely to grow in the future, at least in the western and equatorial parts of the Pacific islands. Management measures are being progressively adopted that require seiners to retain all the tuna catch, including discards, on board as a measure to reduce fishing pressure on juvenile yellowfin and bigeye tuna. This measure is likely to increase substantially the supply of tuna where seiners offload and transship (McCoy and Gillett 2007). Some will be used for canning, but due to the economics of canning small fish, much is likely to be sold in domestic markets. The precise amount is open to speculation, but with the regional purse seine catch being about 1.5 million t in recent years, even a small percentage sold or given away would be a large amount (e.g., 3% would be 45,000 t). Due to the high catch variability and geographic mobility of the seiners, there will probably be periodic gluts and scarcity of this fish.

Aquaculture in the region produces food for Pacific Islanders and tourists, and nonfood commodities for export. Aquaculture production that is not destined for the nutrition of local residents can also make a contribution to food supplies because the income earned can be used to purchase local and imported food.

To investigate production of food from aquaculture for local residents, high-value domestic markets were excluded because most of the expensive aquaculture food does not contribute significantly to food supplies for Pacific Islanders.[4] Accordingly, in this analysis, such items as cultured shrimp and oysters were not included.[5] The amounts of aquaculture commodities produced in 2007 that were likely to become part of local food supplies are shown in Table 26.16.

Table 26.16 shows that about half the countries and territories do not have aquaculture production that contributes significantly to local food supplies. In most countries where there is aquaculture production for local food supplies, it is tiny on a per capita basis, even in the highest consuming countries, Guam and Nauru. Tilapia is by far the most important cultured commodity for local food.

The tabled data further indicate that for most of the countries listed, the contribution of aquaculture to local food supplies is considerably less than that from industrial tuna fishing operations. For the region as a whole, if 10% of the catch of locally based longliners is marketed locally, this amounts to 4,400 t, or over 10 times the local food from aquaculture in the region. There are, however, challenges in distributing this fish to areas away from the longline bases.

Another highly relevant but less evident issue is that most of the meager amount of aquaculture food production in the region is subsidized by governments and/or donors. In Fiji Islands, for example, tilapia production is heavily reliant on government subsidies (ADB 2005).

4 This statement would not apply as rigidly in some of the territories (e.g., New Caledonia).

5 As an extreme example, locally cultured shrimp in Vanuatu was selling at $33/kg in January 2009 (F. Hickey, personal communication, January 2009).

Table 26.16: Aquaculture Production for Local Food, 2007

Country	Commodity	Production (t)	Production per capita (kg/person/year)
Guam	Catfish, Milkfish, Tilapia	152	0.87
Fiji Islands	Tilapia	143	0.17
Papua New Guinea	Tilapia, Carp, Trout	67	0.01
Vanuatu	Tilapia	13	0.06
Samoa	Tilapia	10	0.06
American Samoa	Tilapia	9	0.14
Nauru	Milkfish	8	0.81
Kiribati	Milkfish	4	0.04
Northern Mariana Islands	Milkfish	3	0.05
Cook Islands	Tilapia	2	0.13
French Polynesia	Finfish	2	0.01
Palau	Milkfish	2	0.10
Total		**415**	

kg = kilogram, t = ton.

Source: Country chapters of this report.

Note that SPC (2008b) estimated the amount of milkfish and tilapia produced annually in the region in recent years to be about 552 t (12% of the total aquaculture production of 4,600 t), or about one-third more than that in the table above.

Fisheries and Food Security Issues

A study of fisheries and food security issues in the Pacific islands (Gillett and Preston 2000) identified the major issues in the interface between fisheries and food security. The issues that were especially relevant to the present study are

- lack of effective fisheries management action combined with increasing need for action,
- lack of appreciation of the contribution of fisheries to food security,
- aquaculture not contributing substantially to food security in many Pacific island countries,
- coastal fishery production constrained by postharvest situation,

- reconciling development of export-oriented fisheries with the encouragement of fisheries for domestic consumption, and
- slow development of the private sector.

The Bell et al. (2009) study used current consumption and population growth data to forecast fish requirements in the future for each country of the region. The study indicated that to provide the countries with access to the fish required for food security to 2030 and beyond, national planners and managers need to

- assess whether the potential sustainable production from oceanic (tuna), coastal and freshwater fisheries, and aquaculture, can meet future demand for fish;
- identify how best to "allocate" access to the necessary proportions of production available from these various sources of fish;
- develop systems for catching/producing and distributing fish to deliver these allocations effectively;
- implement policies to support the necessary systems and allocations; and
- oversee efficient management of the systems and other steps in the process.

In addition, information in the present study suggests the following:

- Countries made up of atolls and small islands that attempt to export food fish from inshore and reef areas may end up creating food security problems through declines in food fish availability. Tokelau and some of the Micronesian economies may be in this category.
- Objective economic scrutiny of subsidized aquaculture operations intended to enhance food security could suggest more efficient mechanisms to produce the same nutritional benefits.
- In view of the likely increased availability of tuna from industrial fishing operations in localized population centers, some consideration should be given to the development of systems for distribution to the more remote areas.
- An analysis of fish requirements for a country (including that for local resident nutrition, food necessary for a tourist population, and nonextractive value of fish resources) may suggest merit in discouraging the export of food fish from inshore/coastal areas. This has been considered in Palau and the Maldives.

Measuring Fish Consumption

Some difficulties in measuring per capita fisheries consumption and comparing measurements were mentioned above. Attempts at improving the situation must first address the issue of the objectives of collecting information on fish consumption.

There is a growing need for information on fish consumption and its change over time. Such consumption information is obviously used for monitoring health and diets, but from a fisheries perspective it has many other uses. As shown in Bell et al. (2008), fish consumption rates are important for predicting demand for fish in the future. Probably, the most important fishery-type use of per capita fish consumption is to determine the impacts of policy changes and management interventions, especially on small-scale fishers. Some examples follow.

- Protection of village food fish supplies is arguably the most important objective of subsistence fisheries management in the Pacific islands. Monitoring per capita fish consumption is important in determining the degree to which this objective is being achieved.
- The use of marine protected areas (MPAs) is now widespread in the Pacific islands. It is likely that their use will increase. MPAs are established for many worthwhile objectives, including increasing the abundance of important species, protecting other species, biodiversity conservation, and increasing the value of nonextractive uses (e.g., dive sites). To assure that these multiple objectives are not being achieved at the expense of the diets of villagers living in the area, some monitoring of per capita fish consumption is important.
- If the objective of a government supporting aquaculture is to improve nutrition, it would seem logical to monitor per capita consumption of aquaculture production to determine if the support to aquaculture is effective.

In the country chapters, some studies used estimates of fish production to estimate per capita fish consumption, while other studies used per capita fish consumption (obtained through dietary studies) to estimate fish production. The latter are mainly for crude assessments of production in the absence of other surveys, including HIES. As more countries develop more effective survey tools, the use of fish consumption to estimate production appears to be declining. By contrast, methods of estimating fisheries production using non-nutrition techniques are becoming more prevalent and accurate.

Information in the present study offers suggestions that are both simple and obvious for improving the measurement of fish consumption. Reports of fish consumption studies need to state very clearly what they are measuring: food actually consumed or whole fish equivalent. With respect to the latter term, "whole fish equivalent" or "live fish weight" is often used in the regional literature (and here), but a term that is clearer, more accurate, and less ambiguous is "per capita fish supply." Regional organizations can play a role in encouraging these two aspects of standardization.

Fishery Benefits by Zone

To some degree, the fishery categories used in this report (coastal commercial, locally based offshore, etc.) can be rearranged slightly to represent ecological zones. Combining information from various sections of this report can provide some insight of fishery benefits by those zones, as shown in Table 26.17. It should be noted that, in the partitioning of benefits by zone, some information is exact and/or quantitative, some is qualitative, and some is largely conjecture.

A general observation on the table above is that a large part of the benefits from employment and nutrition—things that directly affect Pacific islanders—come from the coastal zone. The less tangible and more abstract benefits (contribution to GDP, exports, and government revenue) tend to come disproportionately from the offshore area. Pacific islanders have somewhat less direct involvement in generating those benefits, and the benefits reach the average Pacific Islander in a more circuitous fashion.

Table 26.17: Fisheries Benefits by Ecological Zone

Item	Contribution to GDP	Contribution to Exports	Contribution to Direct Government Revenue	Contribution to Employment	Contribution to Nutrition
Inland	4%	Very little, especially after the collapse of the PNG barramundi fishery.	Very little	A substantial number of people are involved in PNG and to a lesser extent in the other countries that have large islands.	Only significant on large islands; about 24,000 t, of which about 75% is from PNG.
Coastal	49%—made up of 19% from commercial, 30% from subsistence	Aquarium fish, bêche de mer, trochus, and other coastal products are responsible for about 10% of the fishery exports of the region.	Very little	If the number of people with "involvement" is combined with the number of people with part-time or full-time employment, this would be by far the largest category. PNG alone has 250,000–500,000 such people.	Very large. All of the 110,000 t from coastal subsistence and most of the 45,000 t from coastal commercial fishing.
Offshore	35%	About 62% of all exports are associated with tuna fishing. Tuna exports from American Samoa are almost half of all fishery exports from the region.	The vast majority of all direct government revenue from the fisheries sector comes from offshore fishing. Access fees for foreign fishing were about $77 million in 2007. Licensing domestic offshore vessels is also significant and likely to be the second most important source in the fisheries sector.	1,169 on vessels and 11,000 in shore facilities.	4,400 t from locally based longliners, plus local sales from canneries, plus leakage from purse seine transshipment.

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Table 26.17: continuation

Item	Contribution to GDP	Contribution to Exports	Contribution to Direct Government Revenue	Contribution to Employment	Contribution to Nutrition
Aquaculture	4%	About 28% of all fishery exports; aquaculture exports from French Polynesia and New Caledonia alone are responsible for about 23% of all fishery exports.	Very little	SPC (2008b) states "Aquaculture may contribute some form of full-time or partial employment for around 25,000 people in the region." The vast majority of involvement with aquaculture in the region occurs in the interior of PNG.	Quite small, 415 t in 2007.
Notes	Estimates are judged to be quite accurate; based on data in the GDP sections of this report.	Estimates are judged to be somewhat accurate; based on data in the export sections of this report.	Estimates contain some degree of speculation because information on nonaccess revenue is not readily available.	The number of PNG people in the various categories overwhelms those in all other countries. It is not possible to determine the relative contribution from each category due to difficulties in comparing "involvement" with formal employment.	Reasonably accurate estimates; based on data in the consumption sections of this report.

GDP = gross domestic product, PNG = Papua New Guinea, SPC = Secretariat of the Pacific Community, t = ton.

Source: GDP, export, government revenue, employment, and nutrition sections in this report.

Issues in Measuring Benefits

Household Income and Expenditure Survey

HIES and the Pacific Islands

Most countries in the region attach great importance to their subsistence and small-scale commercial fisheries. However, it is these fisheries that present the greatest difficulties for the collection of production information. In general, the smaller the scale of fishing, the less is known about production levels, with quantitative information being especially scarce for subsistence fisheries in most countries.

Only a few dedicated fisheries statistical systems in the region attempted to cover small-scale production. The techniques most often used to estimate catches by subsistence and coastal commercial fishing are one-off fisheries surveys, household income and expenditure surveys (HIES), and fish consumption surveys. The HIES and fish consumption surveys are broader than the fisheries surveys and not well known to many fisheries officers. Some comments are made on fish consumption surveys in section 26.5 of this report, while the interface between the HIES and fisheries is explored here.

In recent years, most Pacific island countries have had the HIES. All the independent Pacific island countries and several of the territories are planning for the HIES in the next few years (Haberkorn 2008). The HIES may be a good opportunity to improve the measurement of small-scale fisheries, but some significant problems are apparent in its use for fishery purposes.

SPC's Statistics and Demography Programme kindly provided fisheries information from HIES in 18 Pacific island countries. Information from 10 HIES were used to a significant extent in the present study. The others were not used because of the existence of other sources of data believed to be more accurate, and because of the peculiarities of some national HIES data.[6]

General information on HIES is available from a variety of sources (e.g., Deaton 1997). In the following sections, some observations on the fishery results of the HIES in several countries are made, followed by some general comments on deriving fishery information from HIES, and ideas on improvements.

National HIES versus Fishery Surveys

A feature common in many countries of the region is that coastal fisheries production estimated by the HIES is relatively low. The HIES generally suggests fish catches significantly smaller than that estimated by other survey techniques or smaller than that perceived by specialists familiar with national fisheries. For example, in the eight countries in the present study from which fisheries production levels could be obtained from both the HIES and a more fisheries-focused estimate, the HIES indicated or suggested a lower production in six countries, similar production in one country (Cook Islands), and higher production in another country (Samoa). Information for the eight countries follows.

Federated States of Micronesia

The HIES in 2005 (Statistics Division 2007a) indicated that $23,034,000 was spent on "fish and seafood," of which $15,732,000 (66%) was "home produced" and $9,200,000 was purchased (presumably from either local fisheries or from imports). Unpublished HIES data (supplied by SPC's Statistics and Demography Programme) indicated that 6,806 t of local fishery production was obtained by FSM households in 2005—5,411 t of "home produced" and 1,395 t of "purchased."

Results of a fisheries survey in Pohnpei covering 1998–2008 (Rhodes and Tupper 2007; Rhodes et al. 2008), adjusted and extrapolated to all the FSM, suggested an annual coastal commercial fisheries production in FSM for the mid-2000s of about 2,800 t.

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6 Examples of this are in the Solomon Islands and FSM where it was not possible to distinguish in the HIES between production from coastal, offshore locally based, and offshore foreign-based fishing.

Kiribati

Unpublished data from the HIES in 2006, supplied by the SPC Statistics and Demography Programme, showed that nationwide in 2006 about 2,000 t of fish were purchased for A$5.9 million and 3,371 t of fish valued at A$8.4 million were caught for subsistence purposes.

Preston (2008) carried out field work on fisheries in Kiribati in June and July 2008 and examined multiple sources of catch estimates; he considered the HIES fisheries production estimates to be low.

Marshall Islands

The HIES in 2002 (EPPSO 2002) indicated that fisheries production was 583 t. Staff of EPPSO cautioned that, due to very limited coverage of nonurban areas, the results were likely to be applicable only for Majuro and Ebeye (C. Hacker, personal communication, October 2008).

The present study selectively used several sources of information to estimate (a) a coastal commercial fisheries production in the Marshall Islands in the mid-2000s of 950 t, and (b) a coastal subsistence fisheries production of 2,800 t.

Palau

Unpublished data from the 2006 HIES (Alonz 2007), provided by SPC's Statistics and Demography Programme, showed 189 t of annual fish purchases and 288 t caught for home use.

The total amount from the HIES (477 t) was less than one-quarter of the highly regarded estimate made by PCS (2000) in the previous decade (2,115 t).

Tonga

The HIES in 2000 and 2001 (TSD 2002) indicated 900 t purchased and 613 t caught fish. In late 1990s, coastal fisheries production was estimated to consist of 4,173 t of coastal commercial fish and 2,863 t of subsistence fish (Gillett and Lightfoot 2001).

Discussions with the HIES specialist in the SPC Statistics and Demography Programme suggested that the Tonga HIES seriously underestimated subsistence fishing (G. Keeble, personal communication, September 2008).

Vanuatu

The HIES suggested that subsistence fisheries production in 2006 was 2,116 t. However, a Vanuatu-based fisheries specialist felt that this was quite low (F. Hickey, personal communication, September 2008), based on both his intuition and on the results of a fisheries study in 1983 (David and Cillaurren 1992), which gave an annual production by village fisheries from nearshore habitats of 2,849 t.

Cook Islands

The HIES in FY2006 indicated annual commercial fisheries production of 139 t and subsistence production of 239 t. A study on the situation and outlook for Cook Islands marine resources (MMR 2008) gave similar results for coastal commercial fisheries (within 7%) and for subsistence fisheries (within 20%).

Samoa

The HIES in 2002 suggested coastal commercial production of 4,076 t worth ST30.0 million and coastal subsistence production of 4,437 t worth ST22.8 million.

A nationwide household fisheries survey in 2000 estimated the total annual coastal catch at 7,169 t worth ST45 million (Passfield 2001).

After correcting for fish price changes between 2000 and 2002, the 2002 HIES could be compared to the 2000 fisheries survey with respect to fish production. On that basis, the HIES gave 50% more value and 32% more catch for the coastal commercial component and almost identical catches and values for coastal subsistence fisheries.

The HIES/Fisheries Interface

The Samoa situation above deserves closer scrutiny. Discussion with the HIES specialist at SPC (C. Ryan, personal communication, November 2008) indicated that the quality of Samoa HIES was "as good as it gets." The HIES used individual diaries filled out by respondents over a 2-week period—and the HIES staff stayed in the selected villages during the entire period to monitor record-keeping by the respondents. Interestingly, this was the only HIES covered by the present study that gave a larger estimate of fish catches than the focused fisheries surveys. Thus, one explanation for the large difference between estimates by HIES and fishery studies/surveys in other countries could be the quality of the overall HIES process.

In general, the discussion above suggests some major difficulties of uncritically using the results of HIES for fishery purposes. In practice, in about half of the Pacific island countries, HIES results are a key to estimating the small-scale fishing contribution to GDP. The conclusions of Bell et al. (2009), based on per capita fish consumption from HIES surveys, could easily be different if actual fish consumption was 2–4 times greater than assumed.

Some additional points on the HIES/fisheries interface deserve mention, as follows:

- The HIES can provide more than just information on fisheries production. Much of the information in the present study on fisheries employment and participation in subsistence fisheries comes from HIES.
- The fisheries information produced by the HIES could be less accurate than HIES information on other sectors. The HIES specialist at SPC indicates that some "ground truthing" is done for some types of household expenditures (e.g., cross-checking with actual electricity bills), but not normally for income/expenditures relating to fishing (C. Ryan, personal communication, December 2008).
- The HIES may not just be an option for obtaining information on small-scale fisheries; an improved HIES may represent the *only* cost-effective mechanism for obtaining information on small-scale fisheries. The Vanuatu situation, described in section 15.1, occurs in many countries of the region: "there appear to be two sub-optimal possibilities for estimating subsistence fisheries production in Vanuatu using existing information: extrapolation of an outdated estimate, or the use of the HIES-derived figure that is likely to be very low."
- Comparison of the results of a household survey[7] on an island in Fiji Islands with a creel survey (Kuster et al. 2006) showed that the mean catch was 25%–30% higher in the household survey than what was actually observed in the creel survey. An additional result was that the reported fish consumption appeared to be more accurate than the reported fish catch.

7 This was a fisheries-oriented household survey, rather than the HIES.

- The above examination of the fisheries results of HIES in the region is from the perspective of a fisheries analyst. It suggests that there are difficulties with the HIES fisheries data, but it offers little insight into mechanisms for improvement. By contrast, HIES specialists are familiar with the survey technique and its constraints and opportunities for improvement, although they are less sensitive to the problems of the HIES/fisheries interface and peculiarities of the fisheries sector. This suggests that fisheries specialists should cooperate with HIES specialists on improving the applicability of HIES to the fisheries sector. Indeed, a recent meeting held at SPC discussed how household income and expenditure surveys and censuses could be modified relatively easily to provide better fisheries information (Bell et al. 2008).

Satellite Account for Fisheries

General

The system of national accounts (SNA 1995) categorizes economic activities according to the International Standard Industrial Classification of All Economic Activities (ISIC). In this system, the category relevant to fisheries is ISIC 0500: "Fishing, operations of fish hatcheries and fish farms, service activities incidental to fishing." As such, the SNA sector is closer to what is commonly referred to as "fishing," rather than the broader "fisheries."

The SNA "fishing" sector does not include postharvest activities, which are quite important in many Pacific island countries—and are likely to become more important in the future. The value added by postharvest activities, including fish processing, is generally counted in manufacturing, transportation, and other formal economic sectors.

This classification system and the associated categories of contribution to GDP have important consequences for decision making that affect the fisheries sector. To some degree, sectoral contributions to GDP and their change over time can provide useful information to decision makers—consequences of management action are apparent in variations in GDP contributions. However, if only "fishing" is reflected in the GDP sectoral component and not the postharvest activities, much of the change in economic activity in the fishing/processing industry cannot be readily discerned from GDP data. Also, attention that a government focuses on a sector is to some extent related to the economic importance of the sector. It is unfortunate for the fishing/

processing industry that in many intersectoral comparisons, only part of the industry is considered.

To rectify this situation a "satellite account" can be constructed. Within the framework of the SNA, groups and subgroups of industries can be identified and aggregated to form a satellite that is linked to, but not actually a part of, the main national account. Satellite accounts have been constructed for many clusters of related industries, including information and communication technologies (Australia), ocean industries (Nova Scotia), and nonprofit institutions (several countries). A tourism satellite account is the most widespread example, with over 70 countries having compiled one. Tourism is not an industry in the SNA/ISIC categorization, but rather an amalgamation of activities in various sectors, such as transport, retail trade, etc. By constructing a tourism satellite account, the economic contribution of tourists can be measured, compared, and monitored. The introduction of *Tourism Satellite Account 2002 Fiji Islands* (FIBOS 2002) states:

> "To be able to better understand the true size and value of the tourism industry so as to increase economic growth and create more and better jobs, hard figures that are internationally comparable and reliable need to be produced. So therefore, compiling a tourism satellite account by the Fiji Islands Bureau of Statistics is an important step towards understanding the size and strength of tourism in Fiji."

Satellite accounting presents an opportunity to demonstrate the importance of the broad fisheries sector in Pacific island countries. It is ironic that to date the satellite concept seems to have had the opposite effect—downplaying the importance of fisheries. In Fiji Islands, the satellite account constructed for tourism estimated a contribution to GDP of F$402 million in 2002, representing 11.2% of Fiji Island's GDP for that year (FIBOS 2008). This aggregated contribution has been compared by promoters of tourism to the contribution of other economic sectors (i.e., to the narrow SNA "fishing" category contribution of F$102 million in 2002) to arrive at the unjustified conclusion that tourism is a certain percentage greater than other industries. A correct comparison would be between satellite accounts, but none exists for fisheries.

Although attempts have been made to estimate the aggregate economic contribution of fisheries in some Pacific island countries (e.g., a 2004 cabinet paper in Fiji Islands), no hard figures that are internationally comparable and reliable for the broad fisheries sector have been assembled in any country of the region.

Constructing a Satellite Account for Fisheries

The construction of a formal satellite account for fisheries in a country of the region is far beyond the scope of the present study. The Fiji Islands' tourism satellite account for 2002 took 3 years to formulate, F$750,000 of government funds, and a large technical contribution by Statistics New Zealand. In addition, the World Tourism Organization published guidelines for tourism satellite accounts in 2000 and 2008. No such guidelines exist for the fisheries sector.

For a fisheries satellite account, an assessment could be made of the value added in each of the fisheries subsectors—something that would conceptually mirror what a more complex satellite account would do. Specifically, the Fiji Islands fisheries sector can be defined and specific components identified. Existing information in an ADB report on value added in the various components of Fiji Islands' fisheries sector can be enhanced by estimates for remaining components. The value added in this crude approximation of a satellite account (a "proto-satellite") can then be compared to (a) the narrower fishing sector, and (b) to the tourism satellite account.

Satellite Account for Fiji Islands' Fisheries Sector

The Fiji Islands' fisheries can be defined in a variety of ways. In the absence of international guidelines, considerable flexibility is allowed. For the purpose of the present study, the fisheries sector is defined as the SNA fishing sector plus the activities in the chain of custody of fish products. In national accounting terms, this would be considered a first order account.[8]

Estimates of the value added in 2003 by various components of the Fiji Islands' fisheries are shown in Table 27.1.

To complete the chain of custody (i.e., to aggregate all elements of the Fiji Islands' fisheries sector), several other components of Fiji Islands' fisheries sector have to be added. The additional components not included in Table 27.1 include

[8] A second order account for fisheries would include items related to fishing and postharvest activities, but not directly involved in the chain of custody of fish, with boat building for fishing being an example. A third order account would include spin-off benefits in areas not directly related to fisheries.

Table 27.1: Value Added in Some Components of the Fiji Islands' Fisheries Sector

Component	Value Added (F$'000)
Inshore artisanal	16,578
Marine aquarium	2,800
Subsistence	41,310
Offshore fishery	16,322
Aquaculture	810
PAFCO	6,153
Other fish processors	3,152

F$ = Fiji dollar, PAFCO = Pacific Fishing Company.
Source: ADB (2005).

- domestic marketing of the production of coastal fisheries;
- postharvest activities associated with export of the production of coastal fisheries, including bêche de mer and trochus processing;
- domestic marketing of the production of offshore fisheries; and
- ground and air transport of the export of the production from offshore fisheries.

Information to make a cursory assessment of the value added from these components was derived from discussions with fishing industry participants, staff of the Fisheries Department, Fisheries Department annual reports, recent general economic reviews of the sector (Gillett 2003; Langley and Reid 2004; ADB 2005), the consultant's knowledge of the sector, and specific studies of subsectors cited in the following paragraphs.

A recent study by the University of British Columbia estimated the entrepreneur's value added to the production from Fiji Islands' reef fisheries to be about $2.2 million (F$3.3 million), or about $5,100 per entrepreneur (fish wholesaler), and the value added to be about $5.1 million (F$7.7 million), or about $4,100 per vendor (Starkhouse and Sumaila 2008; Starkhouse personal communication, December 2008). This is for domestic sales of reef species for 2008 only. As in the Fiji Islands section of this report (section 4.1), about 8% should be added to this figure to cover the domestic marketing of nonreef species; 8% could also be subtracted to deflate to 2003 prices.

The DOF (2008a) states that the FOB value of inshore resources exported was about F$31.7 million in 2005. About half of this value was from "marine aquarium" covered in Table 27.1. It is estimated that the value added by the postharvest activities associated with other commodities (non-"marine aquarium") was F$2 million in 2003.

About 12.5% of the production from Fiji Islands' locally based offshore fisheries is marketed domestically. In 2003, the total catch from locally based offshore fisheries was 12,314 t (see section 4.1), indicating a domestic marketing of about 1,539 t of fish. The value added by this marketing is estimated to be F$1 million (R. Dunham, D. Lucas, personal communication, December 2008; and consultant's estimate).

Estimating the value added to the Fiji Islands' economy in the process of transporting fish to international markets (ground/air transport plus handling at Nadi airport) requires more speculation. The available information from company sources indicates the following.

- Ground transport, airport handling, and clerical work associated with the export of tuna result in the employment of about 45 people (full-time equivalents) (R. Dunham, D. Lucas, personal communication, December 2008).
- The largest tuna exporter has had annual airfreight charges of about F$5 million in recent years. The largest exporter handles about one-third of the tuna exports by air, and about 80% of this quantity is on Air Pacific, the national airline (R. Dunham, D. Lucas, personal communication, December 2008).
- A crude approximation of the value added to the Fiji Islands economy in the above shipping operations is F$3.25 million.

Using the value added estimates from ADB (2005) for some of the subsectors of Fiji Islands' fisheries sector in 2003 and making estimates of the remaining subsectors, the total value added can be estimated. Accordingly, the value added by the broad fisheries sector in Fiji Islands in 2003 is estimated to be about F$104,375,000. This figure is about 34% greater than the $77.8 million that ADB (2005) estimated for the narrow SNA fishing sector and would increase the fisheries sector contribution to GDP in 2003 (section 4.2) from 1.8% to 2.3%.[9]

In the tourism satellite account, the contribution to GDP from that sector is 11.2% (FIBOS 2008). Tourism is, therefore, 6.2 times greater than the fishing sector. Comparing the tourism satellite account to the crude fisheries satellite account, the tourism contribution is only about 4.9 times greater. If additional activities were to be included in the definition of the fisheries sector, the contribution would increase. An example of this would be

[9] Fishing industry leaders indicate that 2003 was not a favorable year for comparison, as very poor offshore fishing was experienced that year.

activities that directly input into fishing and processing, such as fishing gear manufacturing or fishing vessel repair.

Utility of a Fisheries Satellite Account

Knowledge of the broad fisheries contribution to GDP, including postharvest activities, would obviously be much more informative and useful for decision making than the narrow fishing contribution. The ability to track changes in the disaggregated fisheries components should allow considerable insight into the dynamics of the fisheries sector and be quite useful, as the following example shows.

In late 2008, when the Government of Fiji Islands was contemplating an export tax on fresh tuna exports, there were no reliable/comparable estimates of the value added in postharvest tuna activities. Consequently, a punitive tax was levied, only to be retracted when some idea of the true value became apparent—in this case through the number of jobs that were threatened by the tax.

Would it be worthwhile doing more work to enable the production of a formal satellite account for fisheries in a Pacific island country? The following are some issues to consider when reflecting on this question.

- The construction of a formal satellite account results in information for decision making that is credible, reliable, comparable, and impartial. Presently, in many countries of the region, the data that come closest to serving the same function are information compiled by the fishing industry that government decision makers often view as biased and/or self-serving.
- The cost of compiling a formal fisheries satellite account is significant. The Fiji Islands tourism satellite account was an expensive exercise that took several years and considerable technical expertise from overseas. While in-house expertise could conceivably be used to compile a fisheries satellite account, most government fisheries agencies in the region have a fairly low capacity in economics.
- It appears that most of the work in compiling a satellite account occurs in the second and third order accounts (related industries and spin-offs, respectively), while much of the utility of a satellite account for fisheries-type decisions would come from the first order.
- Compiling a crude "proto-satellite account," as was done above, could have some utility—even if it gives an idea of the relative sizes of the narrow fishing and broad fisheries sectors (i.e., that the fisheries sector in Fiji Islands is 1/3 larger than the fishing sector).

- Nationally, the construction of satellite accounts in other industries may result in a greater need for a fisheries satellite account, if for no other reason than simply to prevent perception that the fisheries sector is shrinking in relative terms.
- As an alternative to a satellite account for fisheries (the net effect of fishing on economic activity), the "multiplier effect" (Appendix 2) may be worthy of consideration. For example, one dollar of landed fish will generate additional dollars of revenue that will be spent in other service sectors unrelated to fisheries.
- The issue of whether a fisheries satellite account would be used if one were to be constructed should be considered. It appears that such an account would be most useful in a country where there is a sizeable fisheries industry, multiple developments that affect the industry are planned, and various industrial sectors are competing for government attention. An important market for a satellite account is industry "champions," individuals who are influential in stressing the importance of the sector.

Subsidies in Fisheries

A study of fisheries benefits is incomplete without exploring the topic of subsidies. In many cases, subsidies can represent a hidden cost of a benefit. For example, "If government subsidies are considered, the real cost for each job created in FSM public sector fishing companies was $300,000" (Jacobs 2002).

During the present study, it became evident that many fisheries officers of the region do not have a clear understanding of what constitutes a subsidy. The World Trade Organization Agreement on Subsidies and Countervailing Measures contains a definition of subsidy as "a financial contribution by government or an agency designated by government that confers a benefit." In this context, a financial contribution can be (i) direct or potential direct transfers of funds or liabilities (i.e., loan guarantees); (ii) provision of goods or services, other than general infrastructure and purchase of goods; (iii) foregone government revenue (i.e., tax credits); (iv) payments to a funding mechanism that carries out any of these functions; and (v) any form of income or price support.

Subsidies in fisheries are not inherently bad; in fact, they can perform some useful social functions, such as establishing a new fishery in a rural area. However, the following common problems associated with fishing subsidies became apparent in the course of the present study.

- **Lack of Transparency of Subsidies**. Good governance dictates that the public be made aware of the way public funds are spent. Lack of transparency prevents stakeholders from undertaking an alternative assessment of the value of those subsidies—including whether the subsidy is achieving its objective. Lack of transparency for a particular fishery subsidy can create an illusion of a successful activity that others may try to emulate.
- **Lack of an Exit Strategy**. If the intention is to provide a subsidy in perpetuity, there should be explicit government policy recognition of this. If not, there should be an established mechanism and criteria for terminating the subsidy. An FAO report that reviewed fisheries subsidies worldwide (Schrank 2003) made a relevant comment: "Over time, subsidies which once may have served a useful social purpose may have become entrenched and now serve primarily the interests of participants in the industry receiving the subsidies."

Subsidies also cause difficulties for measuring benefits from fisheries. In some cases, they can play a very large role in terms of the operating cost structure of the fleet, with the Spanish swordfish longliners based in some Pacific Island ports being a good example. In addition, the contribution of the fishery industry to GDP is likely an underestimate in countries that subsidize (explicitly or implicitly) farm-gate prices, which will not show up as value added in the national accounts. Even though the production approach has been taken in this report, the VARs estimated may still be distorted by subsidization.

Some additional thoughts on the relationship between subsidies and fishery benefits in the region are given in section 29.2.

Factors that will have Major Impacts on Fisheries Benefits

Climate Change

A preliminary assessment of the effects of climate change on fisheries and aquaculture in the Pacific islands is given in Appendix 4. It outlines how the climate of the Pacific is projected to change, how climate change has affected fisheries elsewhere in the world, and how it is expected to affect fisheries and aquaculture in the Pacific. The information is derived from the early phases of a major regional project to assess the vulnerability to climate change of fisheries and aquaculture in the Pacific. The project is coordinated by the Secretariat of the Pacific Community and supported by the Australian Agency for International Development.

Alterations in ocean temperatures and currents and the food chains in the open ocean are projected to affect the future location and abundance of tuna species in the Pacific island region. Initial modeling indicates that the concentrations of skipjack and bigeye tuna are likely to be located further to the east than in the past. The simulations have yet to be done for yellowfin and albacore.

Significant changes to future distribution of tuna will make the zones of some Pacific island countries more or less favorable for the surface fishery for skipjack tuna. Displacement of tuna stocks further east in the Pacific would be a windfall for the countries in those areas. Reduced abundance of skipjack in Melanesia should have a far lower impact on their GDP in relative terms, but there will be substantial losses in real terms given the large quantities of tuna currently caught there. Identifying the preliminary implications of climate change for longlining operations is not practical at this stage because although initial simulations indicate that there will also be an eastward shift in adult bigeye tuna, the modeling has not yet been done for yellowfin and albacore.

Projections that cyclones will become progressively more intense may increase the risk of damage to shore-based facilities, fleets for domestic tuna fishing, and processing operations in countries located within the cyclone belt. Rising sea level will eventually make many of the existing ports and shore-based facilities unusable.

The projected effects of climate change on coral reefs are better understood than for other coastal habitats. Rising sea surface temperatures and more acidic oceans are projected to have increasingly severe impacts on the growth of hard corals. The expected loss of structural and biological complexity on coral reefs will have profound effects on the types of fish and invertebrates associated with them. Species that depend on live coral for food, and on the intricate variety of shelter created by structurally complex reefs for their survival, are likely to disappear. Effects of climate change on coastal fisheries associated with coral reefs may not be immediately apparent, but result in slow, long-term (decadal) declines in yields as resilience and productivity are gradually eroded.

Projected increases in temperatures, sea level, storm intensity, and turbidity of coastal waters due to higher rainfall, can be expected to affect the growth and survival of mangroves, seagrasses and nonreef algal habitats, and the nature of intertidal and subtidal sand and mudflat areas. These areas function as nurseries for juvenile organisms and/or as feeding habitats for a wide range of coastal fish species. Reductions in coverage and structural complexity of mangroves and seagrasses can be expected to reduce the recruitment success for many species of fish and invertebrates.

Climate change will also affect the freshwater fisheries of the region. The projected increases of rainfall in the tropics are expected to increase the extent and duration of inundation. The effects of increased flooding and higher water temperatures on the fish themselves, and on the vegetated lowland areas that support them, have yet to be determined. Freshwater fisheries throughout the region are based largely on species that migrate between the sea and freshwater. Small changes in either rainfall or sea level may have major impacts on the ability of fish to move between estuaries and freshwater, lowering recruitment.

With respect to aquaculture, climate change could result in losing fish from ponds during floods, invasion of ponds by unwanted species, and damage to ponds through infilling and breaching of walls. However, heavier rainfall in low-lying tropical Pacific island countries and territories may increase the area suitable for rain-fed pond aquaculture. Pearl farming faces risks from increased acidification of the ocean. As aragonite saturation levels fall, the shells of blacklip pearl oysters will be weaker. This is likely to lead to higher rates of predation of juveniles and lower rates of collection of wild spat. The winter mortality disease currently causing problems for the production of blue shrimp in New Caledonia may ease with the changing climate. Higher water temperatures combined with lowered salinity are factors linked to outbreaks of disease that affect production of seaweed. Warmer water temperatures, increased acidification, and more severe cyclones can also be expected to influence the development of aquaculture for marine ornamental products.

Fuel Costs

As part of the present study, an analysis of energy costs and fishing in the region was commissioned by the World Bank. The report (a summary is given in Appendix 5 below) assesses the direct impact of fuel price fluctuations on the financial performance of ongoing fishing operations of domestic fishing fleets in Pacific island countries. The report indicates that the fuel price impact has fluctuated considerably among fisheries and countries. While the largest component of domestic fuel price, the international bulk price, has risen dramatically over the past 10 years (1998: \$20 per barrel for diesel; 2008: \$170 per barrel),[10] very significant variations in fuel prices occur between countries, the lowest price being in French Polynesia (\$0.56/liter) and the highest in Vanuatu (\$1.87/liter).[11]

Tuna longliners have the highest consumption of fuel per ton of catch: on average over four times as much as purse seiners. Small-scale fisheries fall between the two, consuming about twice as much fuel per ton as seiners. The costs of fuel per dollar of catch show similar differences, but less pronounced,

10 All domestic bunker fuel is supplied in automotive diesel oil (ADO), the regional market being too small for suppliers to consider offering other heavier (and cheaper) grades of fuel.

11 In December 2008, the Singapore spot price for automotive diesel oil was \$0.76 per liter, while the average price paid by the fishing industry was \$1.33 per liter, of which \$0.11 per liter was tax.

because prices of some fish products have increased more than others.[12] The financial impact of fuel price increases of longliners is still greater than that of purse seiners but the difference is very much smaller than the difference in specific fuel consumption per ton of catch, on account of increases in fish prices. Artisanal fishers are the most financially exposed of all the fleets analyzed.

Historical trends in the financial exposure of the main fleets to fuel price fluctuations (fish-to-fuel ratio[13]) suggest that for the domestic longline fishery for sashimi grade tuna, this ratio increased by a factor of 4.5 from 1999 to 2008. In the purse seine fishery for cannery grade tuna, the ratio showed two peaks, in 2000 and 2006, when the financial impact of high fuel prices was worse than during the recent peak in mid-2008. Exposure to fuel price change of small-scale fisheries in Fiji Islands has remained relatively constant during the period. Country exposure to fuel price fluctuations suggest that PNG, with by far the largest potential national production, would suffer the largest changes in profits and value added.

The exposure of aquaculture to energy cost fluctuations varies substantially: pearl aquaculture is estimated to consume only about $3 of fuel per $100 of product value; intensive penaeid shrimp aquaculture is estimated to consume 1.7 tons of fuel per ton of product; if feed production were to be taken in to account, consumption would be higher still.

Changes in operations as a result of increasing fuel costs in the offshore purse seine sector have been virtually zero; increased technical efficacy and favorable prices for skipjack and yellowfin tuna offset increased fuel costs. For domestic-based longliners that have had to face increases in fuel prices without product price increases while experiencing drops in catch per unit of effort, modest operational changes have been made. Small-scale fisheries facing higher fuel costs have reduced the distance traveled and changed gear.

Policy options and tools that would reduce the impact of fuel price fluctuations include

- competitive and efficient sourcing of fuel, either through competitive processes or via a regional bulk supply arrangement, and public control of domestic bulk-storage infrastructure;

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12 The principal market for WCPO cannery grade tuna, Bangkok, has shown positive price developments during 2000–2008, similar to the price increase in fuel; relative prices for sashimi quality tuna have declined in US dollar terms.

13 Fish-to-fuel ratio is a measure of the weight of fish catch that is of the equivalent value to the cost of a fixed amount of fuel.

- temporary adjustment of taxation and excise on fuel, targeted at particular sectors;
- establishment of fiscal and other incentives to encourage operators to adopt fuel saving measures or more fuel-efficient fishing technologies, and to diversify fuel usage; and
- raise awareness through training.

Fishery Benefits and Economic Rent

An important aspect of benefits from fisheries concerns the “rent” generated by various management regimes. This rent, sometimes referred to as resource rent or economic rent, is most simply described as the difference between total fishery revenue and fishery costs. Thus, management strategies that contribute to lowering costs and thereby increasing rent create the conditions that can allow maximum benefits to flow from a fishery. Although a complete discussion of the topic is beyond the scope of the present report, a recent study deserves some mention.

In 2008, the World Bank prepared a global report on the economic state of world capture fisheries (“Sunken Billions,” World Bank 2008). The report provided estimates that the annual economic losses from current or actual management versus the potential economic rents were some $51 billion/year with a 95% confidence level that the value is between $27 billion and $73 billion. To complement the World Bank’s global estimate of economic losses from business as usual, regional or “bottom up” models of economic losses from current fisheries management are required. Such a study on the tuna fisheries of the Western and Central Pacific Ocean was undertaken by Grafton and Compass (2009).

This “Tuna Wealth Study” provides a theoretical assessment of the potential regional economic wealth of the tuna resources and the relative economic rent drain resulting from the current fisheries governance model. Using an existing bioeconomic model and open source data for the analysis, it refined the methodological approach for estimating resource rents (and losses) as described in the “Sunken Billions” report.

The method used in the Tuna Wealth Study explicitly accounted for the transition costs in moving from the current biomass and actual effort levels to the optimal biomass and effort levels. Using a planning period of 50 years, and a discount rate of 5%, total profits for purse seine, frozen-fish longline, and fresh-fish longline fleets for 2006 were calculated at $93 million, $120 million, and $109 million, respectively (in 2008 prices). The study estimated that governance based on a business-as-usual approach would generate economic losses in net present value terms of at least $3.4 billion over a 50-year period, compared to optimal harvesting, despite the fact that, overall, the fisheries currently generate positive profits. Sensitivity analyses suggest that economic losses from business as usual are very large in net present value terms under a wide range of alternative scenarios.

An important point to emerge from the Tuna Wealth Study is that consideration should be given to a change in management regime to avoid the very large wealth losses associated with the business-as-usual approach.

Recommendations and Concluding Remarks

Recommendations for Improving the Measurement of Fisheries Benefits

Recommendations for improving the measurement of the main categories of fisheries benefits are summarized in Table 29.1. These suggestions for measurement improvements mostly involve minor or obvious change to established procedures and mechanisms. Improving the measurement of fisheries employment may, however, require more fundamental work.

Fisheries Employment

Information on fisheries employment of the region is scattered and inconsistent. Employment information presented in the country chapters is a heterogeneous assemblage of various types of data. There is no standard nomenclature or standard measurements—attributes that make it difficult to make comparisons. In the many trade-offs that fisheries management entails, it is often important to be able to determine and balance how many people will be affected by decisions. Using actual examples encountered in this study, it is difficult to balance impacts on a type of fishing that "may contribute some form of full-time or partial employment for around 25,000 persons" with a fishing activity that is "the first income for 5% of the households in a

Table 29.1: Improving the Measurement of Fisheries Benefits

Benefit Category	Suggestion to Improve Measurement
Gross Domestic Product	• Statistics staff should obtain technical fisheries expertise when devising methodology, collecting data, making the estimate, and reviewing the results of estimating the fishing contribution to GDP. • Statistics staff should compare the reestimated fishing contribution to GDP in the country chapters of this report to the official estimate and evaluate the differences and any need for modification to the methodology. • When using the production approach for estimating fishing contribution to GDP, the analyst should (a) formulate logical fisheries categories that group similar fisheries with similar value-added ratios; (b) in the absence of specialized economic studies for the concerned country, use the suggested value-added ratios of Appendix 3 of this report; and (c) for estimates of offshore fisheries production, use the WCPFC national fisheries reports. • The results of past "informal" and "specialized" studies used in estimating the fishing contribution to GDP should be critically reviewed. • Estimates of coastal fisheries production should be improved, through refinement of HIES and other mechanisms.
Exports	• Government fisheries agency staff should scrutinize the quantities and values of fishery exports in the official customs department data for erroneous information and omissions. • The official value of tuna exports should be compared with the values on the Forum Fisheries Agency (FFA) spreadsheet "The Value of WCPFC Tuna Fisheries" available from the Fisheries Development Section of the FFA, Honiara.
Government Revenue	• Government fisheries agency staff should reconcile their estimates of foreign fishing access fees with those of the Ministry of Finance. • Clarification should be obtained from the Ministry of Finance on what components of fees received from the US tuna treaty are to be considered payments for fishing access and what should be considered development aid. • The annual reports of government fisheries agencies should provide a reconciled list of access fees and other government income (e.g., domestic fishing license fees)—as distinct from all money received.
Employment	• Conceptual work should be undertaken on the measurement of fisheries employment, taking advantage of worldwide experience both in and outside the fisheries sector. • There should be significant fisheries technical input on the design and implementation of general surveys that are intended to obtain information on fisheries employment.

continued on next page

Table 29.1: continuation

Benefit Category	Suggestion to Improve Measurement
Nutrition	• Reports of fish consumption studies should state very clearly what they are measuring: (a) food actually consumed or the live weight of the fish that produced the food; and (b) the consumption of just finfish or all seafood or all aquatic foods. • The term, "per capita fish consumption, whole fish equivalent" is often used in the region, but a term that is clearer, more accurate, and less ambiguous should be used: "per capita fish supply."

GDP = gross domestic product, HIES = household income and expenditure survey, US = United States, WCPFC = Western and Central Pacific Fisheries Commission.

Source: Chapter 26 of this report.

country." Given that unemployment is arguably one of the most serious long-term problems of the region, there is justification for doing some conceptual work on the measurement of fisheries employment. This would entail taking advantage of worldwide experience both in and outside the fisheries sector.

Consolidated Reporting

Consolidated reporting of the measures of fishery benefits in the region (similar to the present report) should ideally be done every 4 or 5 years. Such a report, giving comparisons between countries and between time periods, would be an important tool for national and regional fishery management agencies and their development partners. Thought should be given to refining such reporting and to institutionalizing its periodic production.

Concluding Remarks

In this report, numerous observations have been made relating to increasing benefits. Obviously, this study cannot result in a remarkable improvement of benefits related to fisheries—this has been the work of national fisheries agencies, regional organizations, and international agencies for a half century. Nevertheless, some overall comments related to fisheries benefits and to their enhancement are offered.

Fisheries Production and Benefits: What Has Been Achieved?

Box 29.1: Summary of Fisheries Production in the Region

Total fisheries and aquaculture production in the region in 2007 is estimated to be 1,327,361 t, plus an aquaculture production of 2,984 t and 305,336 pieces. Total value of this production in 2007 is estimated to be about $2,049,500,000. Offshore foreign-based fishing is responsible for about half of the value of fisheries in the region, offshore locally based for about a quarter, and coastal commercial, coastal subsistence, and aquaculture for the remaining quarter in about equal shares. Between 1999 and 2007, there was a remarkable increase in fishery production by Papua New Guinea and a moderate increase by most other countries. By category of fishing, there were substantial increases in offshore fisheries production, while coastal fisheries production did not change.

Source: Chapters 25 and 26.

Box 29.1 summarizes the status of fisheries production in the region.

Regarding the independent countries of the region, for which comparisons between 1999 and 2007 can be made, the role of fisheries in the economies of most countries increased during the period: the relative contributions to GDP (i.e., share of fishing contribution to total GDP) increased in 11 countries and decreased in 3 countries; and in nominal terms, fishery exports almost doubled. Fishery exports increased relative to total exports in most countries, but fell significantly in the Solomon Islands and Samoa.

Foreign fishing access fees increased in nominal terms for all but three countries, with an overall regional increase of almost one quarter ($18.7 million) in the 7 years between the studies. However, gains were moderated by granting access fee concessions to encourage local basing (i.e., other types of benefits through domestic industry development).

The official and reestimated fishing contributions to GDP (see section 26.1) may seem small, but the fishing contributions (mostly 1%–10% for the reestimations) may actually be large in national account terms. Iceland provides a good example. Iceland's economy is highly dependent on fish and fishing. Fishery products made up 40% of exports in 2007. Despite this importance, the fishing sector contributed only 7% to GDP in 2007 (Ministry of Agriculture and Fisheries 2008). This is because many fishing-related activities are accounted for in other sectors such as manufacturing and much economic activity generated by fishing is attributed to other sectors, such as retail trade.

The fishing contribution range of 1%–10% is also large relative to other countries in the world. In a recent FAO global survey, most developing-country fishing nations had fishing contributions to GDP of slightly more than 1% (P. Jern, FAO, personal communication, January 2009).

Coastal Resources: Reaching the Limits

For the region as a whole, while offshore fisheries are expanding substantially, there has been no overall production increase from coastal fisheries. This contention is quite consistent with a recent policy paper by SPC that stated: “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 nonextractive uses” (SPC 2008b).

The section on fisheries benefits by zone concluded that most of the benefits from fisheries that directly touch the lives of Pacific islanders—employment and nutrition—come from the coastal zone.

Together, these two conclusions have major implications for the region. Limited fishery production expansion in the coastal zone equates to a stagnant amount of food and employment being spread among a growing number of people. In conjunction with the generally expanding offshore fisheries, the distribution of benefits from the fisheries sector in the Pacific islands is likely to undergo a profound change in the future. Another implication is that the government fisheries agencies of the region—many of which are oriented to developing coastal fishery potential—may require a fundamental reorientation to include a strong emphasis on safeguarding the existing levels of food and jobs from the coastal zone.

Subsidies: Hidden Costs of Benefits

In many cases, subsidies can represent a hidden cost of a benefit (see section 27.3). Discussions of subsidies are not common in the fisheries and aquaculture literature of the region. Exploration of the subject could result in any subsidies being more effectively applied or, alternatively, it could point to more effective uses of public funds.

Estimating Production from Coastal Fisheries: The Big Unknown

Estimating the production from coastal fisheries in about half of the Pacific island countries is largely guesswork. In very few Pacific island countries are the levels of coastal catches well known. Monitoring of production from offshore fisheries is relatively efficient, nationally and regionally. SPC's Oceanic Fisheries Programme continues to improve its estimates of catch from offshore fisheries and assists national governments to monitor those fisheries. FFA is in the process of reinvigorating its program that monitors the economics of offshore fisheries, including employing people in each country to assist in these efforts. No such improvements are underway for coastal fisheries at the regional level, and few, if any, countries are embarking on new national initiatives to determine production from coastal fisheries.

The lack of knowledge of catches from coastal fisheries is especially troublesome. This is likely to be a factor in the under-appreciation for these fisheries in many countries. In the present study, it has become evident that poor data on coastal fisheries production create considerable difficulty in accurately portraying fishery benefits, especially in the areas of GDP contribution, employment, and nutrition. Protection of village food fish supplies is arguably the most important objective of the management of coastal fisheries in the Pacific islands, but to know if such management efforts are effective overall, some idea of gross coastal fisheries production is required. In terms of government priorities, it seems that a lack of production information tends to result in a lack of attention. Because these are the fisheries that have the greatest direct effect on the lives of Pacific Islanders (see section 27.6), determining production in coastal fisheries deserves more attention.

The above should not be taken as an argument for establishing systems of ongoing and extensive data collection from coastal fisheries of the Pacific islands. Such systems are expensive to the point of rarely surviving the withdrawal of donor support. Cost-effective mechanisms for periodically obtaining information on gross production from coastal fisheries are needed. The use of the HIES for fisheries purposes was discussed above, but there are other possibilities, including the one-time intensive fisheries "snapshot" survey, as was done in Samoa. SPC, with its Coastal Fisheries Programme and the Statistics and Demography Programme, is in a powerful position to develop, perfect, and promote such fishery measurement tools.

Aquaculture: Improving the Track Record

In this report, there has been considerable discussion of aquaculture, especially in the production and fish consumption sections. The observations and comments on the past performance of the subsector should not be taken to indicate that aquaculture has no potential in the region. *On the contrary, given worldwide trends, it is likely that the contribution of aquaculture to the economies will increase.* With respect to what has been achieved to date, pearl culture is one of the biggest successes in the entire fisheries/aquaculture sector of the region.

During the study, a close examination of the net benefits of aquaculture in each Pacific island country resulted in considerable reflection on the subject of success and failures in the development of aquaculture in the region. Two suggestions for improvement (applicable to both the national and regional levels) can be offered, as follows:

- The development models being pursued should be constantly evaluated for effectiveness, especially in cases where the model has resulted in limited success over many years.
- There should be periodic objective analysis of the net benefits and potential of aquaculture development initiatives.

Access Fees: Getting to Know the Unknown

In the earlier study by Gillett and Lightfoot (2001), considerable secrecy was encountered concerning levels of access fee payments, even at the aggregate national level, and much of the data on access fee payments in that study were estimated with considerable difficulty. For the present study, information on access fee receipts was available in the public domain for most countries. Where this was not the situation, fisheries and/or finance officials cooperated to furnish the information. This favorable change appears to be in accordance with the "Vava'u Declaration on Pacific Fisheries Resources" issued at the Thirty-Eighth Pacific Islands Forum held in October 2007, which stressed the importance of transparency in fisheries licensing arrangements.

Economic Analysis: Assuring Objectivity

Observations during the field work of this study in almost all Pacific island countries lead to two general suggestions for improvement of economic analysis of benefits from the fisheries sector:

- In the analysis of benefits from specific fisheries subsectors, efforts should be taken to assure that the analytical work is completely independent of individuals involved in promoting that subsector.
- Schemes that subsidize various aspects of fisheries should be regularly analyzed by individuals external to the subsidy program to determine whether the objectives of the subsidization are being achieved, whether there is a favorable cost-benefit ratio of the subsidy, and whether alternative mechanisms could be more appropriate or effective than the subsidy.

Promoting the Fisheries Sector: Where Are the Champions?

Measuring the fisheries contribution to the economies of Pacific island countries could be improved markedly by closer liaison between fisheries and statistics agencies. The fisheries agencies are in a position to provide information on new developments, technical insights, and recent data, all of which could improve the measurement of fisheries benefits. This cooperation, however, rarely occurs. Because fisheries agencies have a vested interest in assuring that the importance of their sector is not underestimated, they should take the lead in improving this cooperation.

One reason for the continuing underestimation of the importance and benefits of the fisheries sector is that, with few exceptions, Pacific island countries lack individuals who actively publicize it. By contrast, the tourism sector in many Pacific island countries has champions that rarely miss opportunities to stress to the government and to the public the value of the tourism sector. Therefore, it is no surprise that tourism enjoys the benefits of one of the first satellite accounts in the region (measurement of all activity related to tourism; section 27.2). A recent positive development is that fisheries associations, such as in Tonga, are moving into the role of being champions of the fisheries sector.

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Appendixes

APPENDIX 1

The 2001 Study

The 2001 study led to the production of the document *The Contribution of Fisheries to the Economies of Pacific Island Countries* (Gillett and Lightfoot 2001). The main findings, conclusions, and recommendations of the report are summarized below.

Official Data on the Contribution of Fishing to GDP

According to official data in Pacific island countries, the contribution of fishing to gross domestic product (GDP) in 1999 (or latest prior year available) ranges from 0.6% in Papua New Guinea (PNG) to 12.0% in Kiribati.

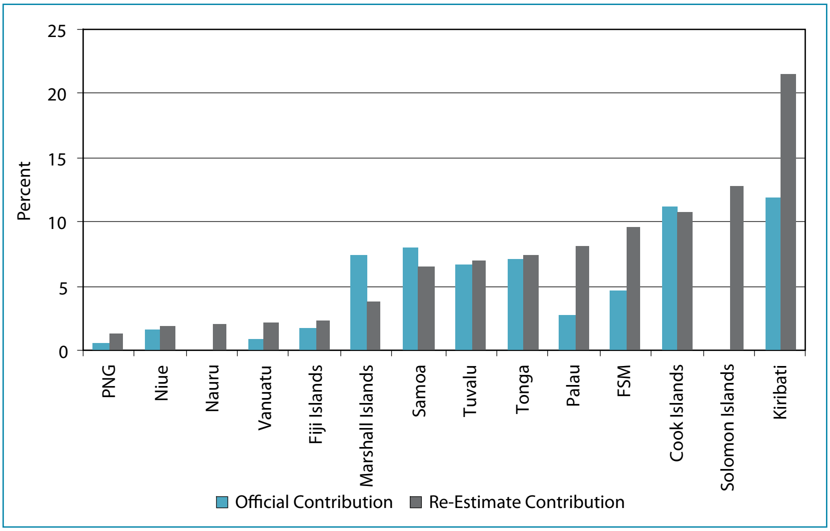
Reestimation of the Fishing Contribution of Fishing to GDP

Given the complexity of the issues to be addressed and the large difference in the accuracy of the official fishing estimates made in the Pacific island countries, it was important for the study to reestimate the fishing contribution to GDP using a consistent method across all countries. It was believed that, at the very least, these estimates would provide useful comparators for the compilers of national accounts. In addition, it was anticipated that the review of the different methods and approaches used in each country would provide useful insights into the effectiveness of alternative approaches to national accounting.

Comparison of Official and Reestimates

The comparison between the official and the new estimates of fishing contribution to GDP is presented on Figure A1.1 below. The largest difference was found in Kiribati, Palau, and Federated States of Micronesia (FSM), where the new estimates nearly doubled or tripled the official figures. By contrast, this study lowered the estimate of fishing contribution to GDP in Marshall Islands, Samoa and, to a lesser extent, Cook Islands. On average, the new estimates indicated a higher contribution of fishing to GDP than reported by national statistics (7.0% versus 5.4% across all countries).

Figure A1.1: Comparison of Official and New Estimates of Fishing Contribution to the Gross Domestic Product of Pacific Island Countries



FSM = Federated States of Micronesia, GDP = gross domestic product, PNG = Papua New Guinea.
Source: Corresponding tables in country chapters.

Major Reasons for Difference in Estimates of Fishing Contribution

In some countries, notably FSM and PNG, the difference in estimates is primarily due to subsistence fishing not being included in the official figures. In other countries, in particular, Palau, the differences are primarily due to the methods used. For most countries, it is a combination of differences in the estimate of production and the method used to calculate the GDP contribution. In Samoa, for example, subsistence production was valued at the full market value, rather than at "farm-gate" prices. Cook Islands, Niue, Tonga, and Tuvalu all compile soundly based national accounts that include reasonable estimates of fishing contribution. Nauru and the Solomon Islands have weaknesses in compiling national accounts.

Common difficulties associated with calculating the contribution of fishing to GDP

The common difficulties found in estimating the contribution of fishing to GDP in many Pacific Island countries include

- **Fisheries Technical Input.** Lack of coordination exists between fisheries agencies and statistical agencies in the calculation of fishing input.
- **Treatment of Subsistence Fisheries.** There is often a lack of data on subsistence fisheries and difficulties in isolating fishing from other subsistence activities.
- **Fish Processing.** Because in the national accounting scheme the processing of fish is outside the "fishing" sector, it is often not possible to isolate the contribution of this important fishing-related activity from other forms of food processing.
- **Export Data.** Official export figures in the Pacific island countries characteristically undervalue exported commodities, especially fisheries products.
- **Economics of Small-scale Fisheries.** Data on small-scale fisheries are often scarce, as is technical assistance for its analysis.
- **Lack of "Champions."** There is often a scarcity of individuals in Pacific island countries who are vocal at stressing the importance of

the fisheries sector, contributing to its undervaluation in national statistics.

Fishery production in specific Pacific island countries

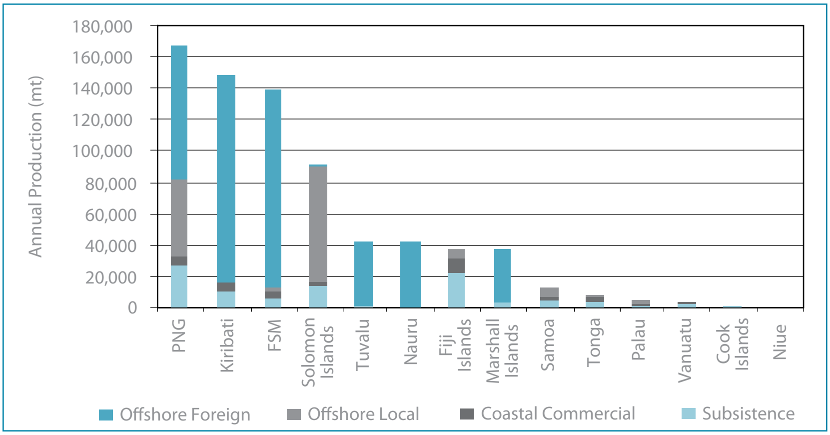
Figure A1.2 and A1.3 show the estimated fisheries production and annual value in Pacific island countries.

Fishery production patterns

Key patterns in the fisheries production data include the following:

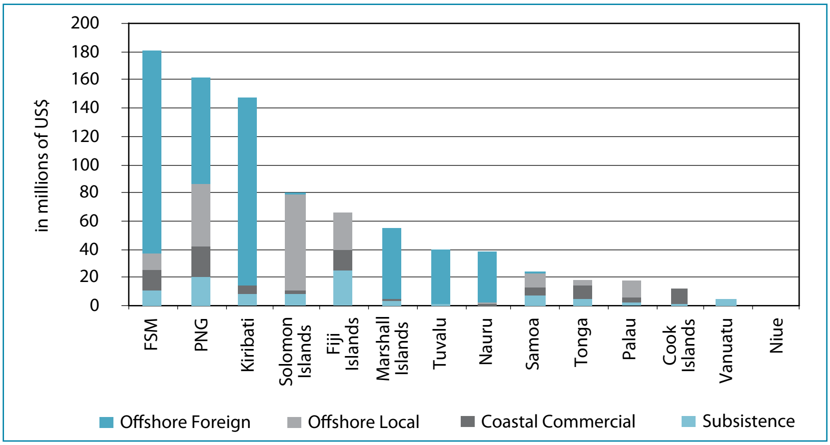
- The weighted average price per kilogram (kg) in the region is $1.04 for subsistence fisheries, $2.41 for coastal commercial fisheries, $1.28 for locally based offshore fisheries, and $1.04 for foreign-based offshore fisheries.
- The ranking of countries by total fisheries production is strongly influenced by the level of tuna catches.
- There is a general pattern of total national catches decreasing going from west to east across the region, and from equatorial to higher latitudes.

Figure A1.2: Estimated Annual Fisheries Production of Pacific Island Countries, late 1990s



FSM = Federated States of Micronesia, mt = metric ton, PNG = Papua New Guinea.
Source: Corresponding tables in country chapters.

Figure A1.3: Estimated Value of Annual Fisheries Production of Pacific Island Countries, late 1990s



FSM = Federated States of Micronesia, PNG = Papua New Guinea.
Source: Corresponding tables in country chapters.

- The higher value of longline tuna relative to purse seine tuna is apparent from the ranking of FSM where a relatively large proportion of the catch is taken by longline vessels. FSM ranks third by quantity and first by value.
- Fiji Islands appears to have the largest non-tuna production, in terms of both quantity and value.
- The production from Nauru and Tuvalu is almost entirely related to tuna fishing.

Fisheries-Related Employment

Certain observations can also be made about employment in the fisheries sector, as follows:

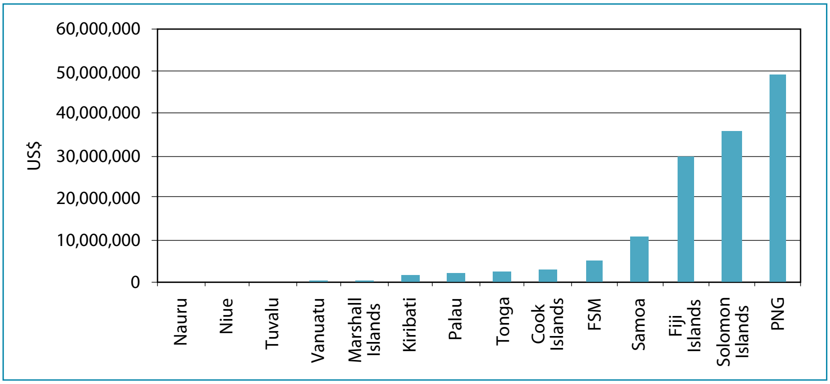
- The importance of fisheries in the subsistence economy seems to be strongly related to the type of island. In decreasing importance, atolls, islands, and large high islands are associated with very different levels of significance. This pattern is somewhat altered by PNG with its important freshwater subsistence fisheries.
- The importance of formal employment in fisheries seems to be related more to business conditions than to island type. Most formal employment in fisheries appears to be tuna-related.

- The importance of women employment in fisheries is generally understated due to (i) the practice of classifying activity according to a person's "main unpaid activity," which masks the importance of secondary activities—e.g., for many women, childcare is often the "main unpaid activity" so any fishing activity, even if it is a substantial amount of activity, is not duly reported; and (ii) placing commercial fish processing (where many women are employed) in the manufacturing sector.
- Where commercial fish processing occurs (canning, loining) and when this is attributed to the fisheries sector, the increase in fisheries employment is remarkable.

Fishery Exports

The most notable feature of fishery trade data in the Pacific islands is the underestimation of the value of fishery exports. This underestimation appears large and is probably worse than in other trade sectors. In most cases, when the official export values are compared to other sources of similar information, the differences are remarkable. Figure A1.4 provides estimates of fisheries exports for end-1990.

Figure A1.4: Estimated Values of Fisheries Exports of Pacific Island Countries, late 1990s



FSM = Federated States of Micronesia, PNG = Papua New Guinea.

Source: Corresponding tables in country chapters.

Features of the Fishery Import and Export Data

Some of the key features of fisheries trade in the region are as follows:

- In general terms, the region exports tuna and other high-value species such as trochus and bêche de mer, while importing canned and inexpensive frozen fish.
- Tuna products dominate the fishery exports of the region. For the five main exporting countries, tuna (fresh, frozen, and processed) overshadows all other fishery exports.
- Canned mackerel dominates the fishery imports.
- The relatively new aquarium fish industry accounts for a significant portion of fishery exports. Aquarium fish exports now account for 78% in Kiribati and 95% in Marshall Islands of all their fishery exports.
- A considerable inter-annual variation is noted in fishery exports.
- Fishery products exported as passenger baggage is quite large, especially in Marshall Islands, FSM, Palau, and Samoa.

Access fees

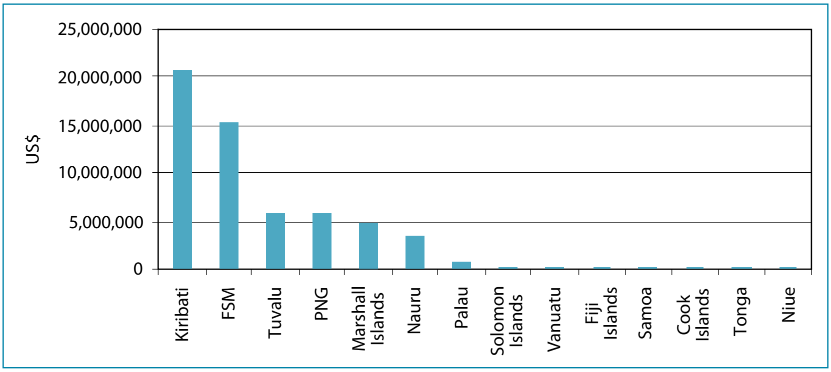
All Pacific island countries received fees for foreign fishing activity in their waters. In some countries, the access fees form a very large portion of government revenue. In FSM, for example, the 1999 access fees represented an estimated 39% of nontax revenue and 22% of total domestic revenue. In Kiribati, 34% of government income in 1999 was derived from fishing license fees. Figure A1.5 summarizes the value of access fees received by the different Pacific island countries in 1999.

Fish Consumption

Key features of fishery product consumption in the region include

- In general, countries made up of predominantly small islands have high fish consumption rates, while large island countries have low consumption rates. Exceptions to this are Tonga where data suggest surprisingly low fish consumption rates, and Palau where fish consumption is remarkably high.

Figure A1.5: Estimated Access Fees from Foreign Fishing Vessels, 1999



FSM = Federated States of Micronesia, PNG = Papua New Guinea.

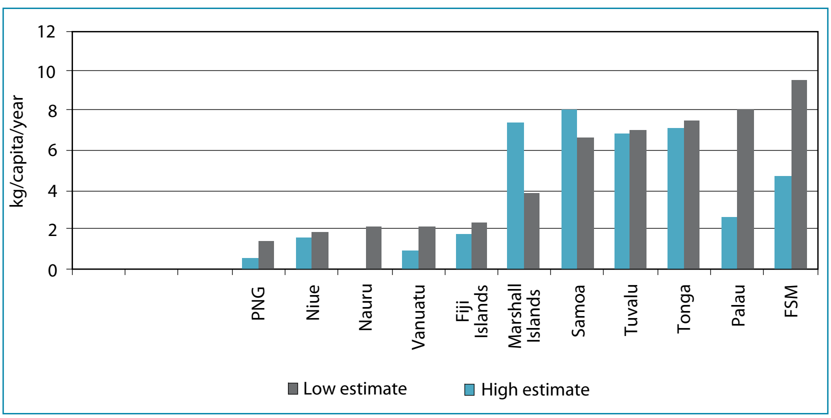
Source: Corresponding tables in country chapters.

- Most of the Pacific island countries exceed by a large margin the world average per capita fishery product consumption rate of 13.0 kg.
- Most estimates for Kiribati indicate that it has the highest rate of fish consumption in the world.

The estimates of per capita consumption are summarized in Figure A1.6.

Ranges in per capita Fish Consumption

Figure A1.6: Ranges in Annual Per Capita Fisheries Consumption for Pacific Island Countries in the 1990s



FSM = Federated States of Micronesia, kg = kilogram, PNG = Papua New Guinea.

Source: Corresponding tables and discussion in country chapters.

Major Conclusions and Recommendations

A major conclusion of the present study is that fisheries contribution to GDP is underestimated in most Pacific island countries.

In countries where estimates of fishing contribution to GDP are markedly different from estimates made in this study, the process used in preparing the national accounts tends to rely on dated surveys, weak indicators, and/or poorly understood methods. It is recommended that, in these countries, the compilers of national accounts carefully examine and evaluate the data, the assumptions, and the methods used.

The accuracy of the estimate of fishing contribution to GDP could be improved with a closer liaison between fisheries and statistics agencies. Fisheries agencies are in a position to provide information on new developments, technical insight, and recent data, all of which could improve GDP estimates. This cooperation, however, rarely occurs in Pacific island countries. Because fisheries agencies have a vested interest in assuring that the importance of their sector is not underestimated, they should take the lead in improving the liaison with the compilers of national accounts.

One of the factors that often resulted in an underestimation of fisheries contribution to national economies is limited available information on the production of small-scale fisheries. Throughout most of the region, statistics on small-scale fisheries are incomplete, inaccurate and, in some cases, absent. Given this reality, it is recommended that maximum use be made of survey opportunities outside the fisheries sector. At little cost, production information on small-scale fisheries could be collected through such tools as the national census, nutrition surveys, agriculture censuses, household income and expenditure surveys (HIES), and poverty studies.

In many countries, the underestimation of the value of fisheries exports in official customs statistics is a major source of error in calculating fisheries contribution to national economies. It appears that export information could be worse in fisheries than in most other sectors. In countries where this problem is especially acute, it is recommended that export valuation be based on a broader spectrum of information than what is provided by customs.

Additional information on the economics of small-scale fisheries would contribute to improving measurement of the fisheries contribution to GDP. Studies to gather the required data need not be complex but should cover the major small-scale commercial and subsistence fisheries.

Where compilers of national accounts have access to comprehensive and detailed information on income and/or expenditure of participants in one or more sectors of the fishing industry, the income approach is the most appropriate method. In the Pacific, it is, however, rare for this data to be available. In these circumstances, the production approach is likely to produce the most accurate results.

Regional organizations could help in improving the measurement of fisheries in the economies of their member countries.

APPENDIX 2

National Accounting and the Fisheries Sector

The Contribution of Fisheries to the Economies of Pacific Island Countries (Gillett and Lightfoot 2001) went into considerable detail in discussing points in the system of national accounts (SNA 1993) that are especially important to the fishing sector. Because that discussion is quite relevant to the present study, it is repeated here.

Definitions and Conventions in the System of National Accounts

As with any system, a set of procedures and conventions is used in compiling national accounts. The nature and application of these procedures and conventions must be taken into account when interpreting national accounts. Some of the important SNA concepts applied to the fishing sector are given below.

Productive Activity

One of the most basic issues in preparing national accounts is the nature of activities that are included in estimating domestic product. In particular, any goods or services produced by a resident of a country for sale are included. Goods and services that are for sale are known as market production.

Service activities that are for personal or households' own consumption are not included in the calculation of national accounts. For example, house cleaning is not included if carried out by the family. These goods and services are known as nonmarket production or subsistence production. However, if goods produced for own consumption could reasonably be sold, they are included in the national accounts. Subsistence fishing is an example. While the fish may have been caught for a family's own consumption, convention assumes that the fish could have been sold and, therefore, it should be treated as adding value to the economy. Clearly, this can be a significant issue in fisheries in the Pacific island countries where large numbers of households rely on the harvest of aquatic resources for food and other uses.

Residency

The nature and extent of residency is a core concept of the SNA. It defines what shall be counted as domestic product. For goods and services to be included in the domestic product of a particular country, a resident of that country must produce them. A resident is an individual or enterprise whose "center of economic interest" is within the country. The "center of economic interest" is determined by the following tests:

- Do residents of the country, in whose area the fishing activity occurs, get significant factor payments (i.e., wage or operating surplus) from the activity?
- Does the government of the country or the individual or the business entity located in the country, in whose area the fishing activity occurs, have a day-to-day influence on the way the fishing is carried out?
- Is the fishing based in the economic territory and/or employing local staff?
- Is the fishing an integral part of the domestic economy?

It is important to note that a resident need not be a citizen. The production of foreign nationals is treated as domestic product provided the country is the "center of economic interest" for the enterprise or individual.

This concept is particularly important in the case of fishing where many of the enterprises are mobile, and it is common for vessels to be staffed by nationals from different countries. In effect, this means that the product of locally based offshore foreign vessels is treated as domestic product of the country from which they are operating regardless of the nationality of the crew.

Under the SNA, the standard convention is to treat activities by a foreign operator that take place in a country for less than 12 months as being foreign activities. In the case of fishing, it is common for offshore foreign vessels to fish for only part of the year in local waters. In these circumstances, a strict interpretation of the SNA convention on "time in country" would treat these activities as foreign and only include the license fees as part of the national accounts. However, where the activities are seasonal and the main activity of the vessels is based locally, it would be more appropriate to follow the "center of economic activity" convention and count their production as domestic product.

A related issue, which is particularly important in fishing, is the geographic extent of the "center of economic interest." The SNA convention is to treat any activity as domestic provided it takes place within the "economic territory" of the country. The SNA boundary for domestic activity is not limited to the political boundary. It extends to include the "economic territory." This convention has particular importance for fishing, especially offshore fishing, which can take place a considerable distance from the land and political boundaries of a country. For example, the political boundary is usually confined to the territorial seas, which extend out to 12 nautical miles from the high water level. In practice, most countries use their exclusive economic zone (EEZ) when defining the geographic limits of their "economic territory" and in the circumstances, this practice is the most appropriate.

Two other "geographic" issues that must be addressed in fishing are (i) how to treat fishing activities that take place in other jurisdictions, and (ii) how to treat those that take place in international waters.

When fishing occurs in the waters of another country, that activity can be determined in the national accounts based on the duration and its "center of economic activity." The SNA indicates that temporary work in a foreign country should be treated as domestic product in the home country (the center of economic activity) of the entity carrying out the job. For example, the income earned by a consultant who normally resides in Fiji Islands and undertakes a short-term contract in Samoa would be treated as Fiji Islands' domestic product, i.e., it is tantamount to an export (of services). SNA, Section 6.239 states:

> "It should be noted, however, that GDP is not intended to measure the production taking place within the geographical boundary of the economic territory. Some of the production of a resident producer may take place abroad, while some of the production taking place within the geographical boundary of the economy may be carried out by non-resident producer units. For example, a resident producer may have teams of employees working abroad temporarily on the installation, repair or servicing of equipment. This output is an export of a resident producer and the productive activity does not contribute to the GDP of the country in which it takes place. Thus, the distinction between resident and non-resident institutional units is crucial to the definition and coverage of GDP."

This being the case and in the absence of any indication to the contrary, such as the formal relocation of the operation, fishing activity of less than 12 months in foreign waters should be treated as domestic product in the home country of the vessel owner and/or operator.

Following the same convention, fishing that takes place in international waters may be domestic product of a country provided the operation is carried out by a resident and is temporary in nature. In some circumstances, fishing carried out in international waters could become a particularly perplexing problem for the compilers of national accounts. Where a fleet operates in international waters most of the time, including transshipping and resupply, the question of whether to allocate the production as domestic or national product becomes an issue.

It is difficult to set strict rules because each situation is different. In practice, the compilers of national accounts will make judgments about where to allocate production of fleets that occurs on the "boundaries" of countries and nationality.

Valuation

In all cases, national accounts are reported in monetary terms. Usually the local currency is used and, almost always, accounts are presented in current market (nominal) values and constant (real) values. Current market values use the value of the currency at the time of measurement. Constant values are indexed to the price levels of a specified year so as to remove the effects of price inflation and thereby allow the comparison of real changes over time. It is also common for international agencies, such as Asian Development Bank, International Monetary Fund (IMF), United Nations (UN), and The

World Bank, to produce national accounts using the equivalent value of a convertible currency, usually the United States dollar. This practice makes it easier to do cross-country comparisons and to track the changes in each country's international competitiveness.

An important valuation convention that is particularly relevant for fishing is the treatment of nonmarket household production (subsistence). Since by definition these items are not sold and the quantity produced is seldom recorded, it is necessary to make assumptions about their value. It is common practice to value nonmarket household production conservatively and, in some cases, production for own consumption is not even included in the national accounts.

Assets

In the SNA, assets are restricted to things that are produced by an economic activity. This distinction is particularly important for natural resources and is a contentious issue, especially in relation to the overexploitation of natural resources.

Naturally occurring assets, such as marine resources, minerals, and forests, do not enter the national accounts until they are being exploited and then only to the extent that they are being exploited. Unlike changes in inventories of produced assets, changes in the quantum of natural assets are not reflected in the national accounts. This convention ignores the very real impact that changes in abundance of natural assets have on the "wealth" of an economy. This can result in misleading values being reported on fisheries and other sectors that rely on natural resources. For example, the income generated from the exploitation of fish is included in the national accounts, while the changes in abundance are not. In these circumstances, the short-term gain from the overexploitation of a fish stock shows up as a positive gain for the economy. If the changes in abundance were also taken into account as happens with inventories of "produced assets," the apparent benefits for the exploitation of natural assets would be substantially reduced.

Fishing versus Fisheries

For the purpose of clarity, it is useful to distinguish between the terms "fishing" and "fisheries." "Fishing" is commonly used to describe the various activities involved in the harvest of aquatic resources, whereas "fisheries" is usually used to describe a broader range from capture through postharvest handling, transport, processing, and marketing.

The conventions used in the SNA and those followed in this report are somewhat different. The categories of economic activities recognized by the SNA are those of the International Standard Industrial Classification of All Economic Activities (ISIC). In this system, the category relevant to fisheries is ISIC 0500: "Fishing, operations of fish hatcheries and fish farms, service activities incidental to fishing." It is important to note the following:

- Postharvest activities, including fish processing, are not included in the fishing sector, but rather they are generally counted in manufacturing and other sectors.
- Aquaculture is included in the sector.
- Subsistence fishing is a legitimate component of the fishing category.
- For convenience, the sector is usually referred to as "fishing."

Weaknesses of GDP

It must be kept in mind that GDP is an *estimate* of economic activity; it is seldom a precise calculation. Even though the SNA sets out fairly straightforward procedures, in practice, the analyst is usually confronted with many uncertainties. Data are often unavailable, incomplete or suspect; hence, the analyst is forced to make judgments about what data to use and how those data should be treated. Some people may find this apparent lack of rigor disturbing, but it is usually unavoidable, especially in complex sectors like fishing. To make matters worse, the fishing sector is often only a small part of GDP, which means that only a limited amount of the analyst's time and effort can be expended for collecting data to update the estimate.

Typically, the sources of data an analyst would use to estimate the contribution of fishing include income and expenditure data from commercial operations, fisheries production and marketing information, and household income and expenditure data. Sometimes, secondary data, like social security records, air cargo records, international market reports, and various reports that bear on aspects of the industry might be used. The choice of which data set to use depends upon the analyst's judgment about the accuracy of the data, the coverage, and the ease of accessing the information.

GDP and its component parts provide an important and very useful guide to the structure of an economy, but they do not show the impact of any activity on the economy. For example, fishing contribution to GDP is limited to its value added to the economy, but the flow effects from the activity of fishing appear as value added by other sectors of the economy. The difference between "contribution" and "impact" can be illustrated by considering the consequences of an increase in fishing activity. If the amount of fishing activity increases by \$1.0 million and the intermediate costs used in this activity are \$0.4 million, then GDP will increase by \$0.6 million. At the same time, the \$0.4 million spent on the intermediate costs will directly increase the level of activity elsewhere in the economy. If \$0.1 million of the \$0.4 million were spent on provisions, the contribution by the "Wholesale and Retail" sectors to GDP would increase by \$0.1 million less any intermediate costs. In addition, the \$0.6 million that has now been added to the fishing contribution to GDP is principally wages and profits, most of which will be spent by the recipients on goods and services. This, in turn, will increase the level of activity in other sectors of the economy.

The people who benefit from the sale of goods and services from "fishing" will in turn purchase goods and services from others, and thereby stimulate further activity. The cycle of activity generated by the initial production will have ripple effects throughout the economy. The aggregate impact will depend on the extent to which the goods and services purchased are produced domestically and the proportion of their income that people spend or save. The net effect on economic activity will almost certainly be far greater than the contribution to GDP. This cycle of impact is known as the multiplier effect.

In practice, the multiplier effect can be fairly difficult to calculate. The dynamic nature of economies means that every action will be followed by a reaction. Changes in a sector will be at least partly offset by changes in the structure of the economy. This was illustrated by the response of households in Samoa to the impact of taro blight on their primary subsistence crop. Most households responded by switching their food production efforts to alternative crops, notably plantains. So while the level of economic activity committed to taro production contracted, in terms of the overall level of economic activity in the economy, this contraction was largely offset by the increase in the level of activity in plantain production. While it was beyond the scope of this study to identify the multiplier effects of fishing, it remains an important issue.

APPENDIX 3:

Guidelines for Calculating the Fishing Contribution to GDP

General

As with the estimation of any contribution to gross domestic product (GDP), the most appropriate method to use will depend on the nature of the data and the resources available to collect and analyze these data.

The compilers of national accounts must strike a balance in their desire for accuracy and the limitations on the time and effort they can dedicate to collecting and analyzing data. In the case of fishing, striking this balance means that they are usually limited to using generalized estimates of income or production. In the consultant's opinion, the minimum level of aggregation that should be used would divide fishing into three categories: (i) locally based offshore fishing (foreign-based fishing in a country's zone does not contribute to that country's GDP), (ii) coastal commercial fishing, and (iii) coastal subsistence fishing. In the Pacific island countries that have significant freshwater fisheries (e.g., Papua New Guinea [PNG], Fiji Islands) or aquaculture (e.g., Cook Islands, New Caledonia) these categories should be added.

In general, where good and comprehensive data exist at the fishing enterprise level, the income approach to estimating fishing contribution is likely to be the most accurate, informative, and timely. Some of the recent DevFish studies are in this category (e.g., Philipson 2006, 2007; P. Philipson, personal communication, November 2008). Unfortunately, such data at the enterprise level are usually not available; data either do not exist or are confidential. Applying the income approach to estimating GDP becomes especially difficult when dealing with the many small companies involved in coastal commercial fishing in most Pacific island countries. The production approach may be the only viable option for calculating fishing contribution to GDP.

Although the production approach may be the most practical method to use in estimating fishing contribution to GDP, compilers of national accounts should, in many cases, be aware of, and compensate for some important weaknesses in that approach, which are as follows:

- The assumption of fixed value-added ratios (VARs) (discussed in the following section). In practice, these ratios are subject to substantial variation, more so than in any other industrial sectors. Major causes of this are changes in catch rates and in prices.
- The difficulty of estimating prices. Typically, prices for fish vary widely by fish size, species, product form, season, and market so that average price estimates derived from price data, as opposed to revenue data, can be substantially inaccurate.
- The need for specialized knowledge of the fishing sector. While compilers of national accounts using the income approach can deal with fishing companies in much the same way that they deal with any commercial enterprise, the production approach requires greater insight into the special attributes of the sector. This involves knowledge of items like identification and/or inclusion of all significant components of the fishing sector, the aggregation of the similar components of the fishing sector (discussed above), determining VARs, and estimating prices.

The difficulties with the production approach can be at least partially compensated for in several ways. Periodic surveys can be undertaken to "ground truth" the assumptions on VARs and prices. Export data can be used to estimate the production of large-scale commercial fishing, but (as explained in Section 31.2) official export figures are often inaccurate. In many countries, the most appropriate mechanism for dealing with the difficulties with the production approach is simply more frequent and effective liaison between compilers of national accounts and government fisheries officials.

Value-Added Ratios

The production approach to estimating fishing contribution to GDP requires two basic sets of data: (i) value of gross output of fishing, and (ii) intermediate costs.

It is usually convenient to express intermediate costs as a proportion of the gross output. For example, in the case of small-scale fishing, using motorized boats, the fuel, bait, provisions, and maintenance are all intermediate costs. If total value of the catch is $1,000 and the sum of the intermediate costs is $400, then the proportion of the gross output attributable to intermediate costs is 40%. Therefore, the value added by small-scale fishing using motorized boats is $1,000 * (1-0.40) = $600. In this example, the intermediate cost ratio is 0.40 and its reciprocal, 0.60, is the VAR. It should be noted that intermediate costs refer to operating expenses. Expenditures on large capital items, such as engines, are capital expenditures and are thus not counted as intermediate costs.

In practice, each operator is likely to have a different VAR. However, in the preparation of national accounts, it is usually not possible to individually measure each operation. The normal practice is to estimate an *average* VAR for each type of activity for each country.

Calculating Value-Added Ratios

Offshore Fishing. All enterprises involved in this sector are large-scale commercial operations. Of necessity, these enterprises keep records of their income and expenditure from which it is possible to calculate a VAR. It should be noted that if income and expenditure data are available for every enterprise in the sector, an income approach to calculating the VAR would normally be used. However, when this is not the case, analysts must resort to using a production approach based on overall production from large-scale fishing and price data. In these circumstances, a sample of the income expenditure of one or more typical enterprises can be used to calculate the VAR for the sector.

Coastal Commercial Fishing. This sector is usually more diverse than large-scale commercial operations. There is often a marked difference in the type of vessel used by each enterprise. Typically, the vessel used could be specially designed fishing boats with inboard motors, outboard skiffs, and canoes. The cost of operating each type of vessel differs and, hence, the VAR of the related activity also differs. Some enterprises may keep income and expenditure records, but many do not. Also, it is often difficult to split the sector catch between each class of activity. In such circumstances, the analyst usually must resort to using a generalized estimate of VARs based on information about the composition of the fleet. To estimate the VARs for small-scale fishing, information may be available from (i) the records of development banks and other financial institutions, (ii) surveying the sector, (iii) published reports on the sector including studies on the benefit and/or cost of proposed development projects, and (iv) anecdotal information from discussions with people involved in the sector.

Subsistence Fishing. The subsistence sector is also quite diverse. Subsistence fishing can include gleaning, canoe fishing, gill netting, cast nets, fish drives, fish traps, torch fishing, and trolling from motorized skiffs. While the VAR for each activity is different, in general, it should be possible to categorize subsistence fishing into two sets of activities: (i) those that involve motorized boats, and (ii) those that do not. The non-motorized fishing activities have a very low level of intermediate cost and, therefore, a high VAR. It would be rare to have less than 90% VAR for non-motorized activities. In contrast, motorized subsistence fishing activities range from high-cost trolling to medium- and low-cost bottom fishing. Estimating the VAR of the non-motorized activities is likely to prove most difficult but, given the high percentage of value added in these activities, slight errors in the VAR used for them is unlikely to result in a major difference in their estimated contribution to GDP. The value added from motorized subsistence fishing activities should be very similar to that of the small-scale commercial fishing. Given the difficulty in separating the gross output of each activity in the subsistence sector, a reasonable approach is to estimate an average VAR weighted by the proportion of the catch (by value) taken by non-motorized and by motorized fishing activities.

Aquaculture. Village-level aquaculture in the region, most commonly involving tilapia and seaweed, has characteristically low intermediate costs. Financial records are often not maintained and consequently, estimating value added can involve considerable speculation. On the other hand, the relatively large-scale aquaculture operations of the region, mostly pearls and shrimp, have much higher intermediate costs. Good financial records are kept, but commercial secrecy becomes an issue in accessing the data for determining value added.

Freshwater. No good data exists on overall freshwater fishery production in any Pacific island country and any estimate involves a considerable amount of guesswork. Most of the production is for subsistence purposes and should be valued accordingly. The catch is mostly taken with low-technology gear, associated with high VARs. In some Pacific island countries, a significant level of non-subsistence freshwater fishing is conducted, such as commercial fishing in the rivers of PNG, and the capture of *Macrobrachium* shrimp for roadside sales in Fiji Islands.

Value-Added Ratios from Previous Studies

The VARs used by the earlier study (Gillett and Lightfoot 2001) are given on Box A3.

Although the above VARs were the best available at the time, there has been considerable room for improvement. The Gillett/Lightfoot report stated: "Additional information on the economics of small-scale fisheries would contribute to improving the measurement of the fisheries contribution to GDP." Accordingly, the present study devoted considerable attention to gathering information from which improved VAR could be derived, with an emphasis on small-scale fishing and aquaculture. Data in the various reports of different types and scales of fishing were scrutinized and VARs were calculated (Table A3.1).

It should be noted that the ratios in Table A3.1 should be considered indicative, rather than precise. In many of the studies listed, there is a lack of information on taxes, depreciation, and loan interest—which may have several percentage points of effect on the VARs.

Some work has been conducted recently on VARs for offshore tuna fishing in the region. In 2006 to 2007, the Forum Fisheries Agency/Secretariat

Box A3: Value-Added Ratios used in Gillett and Lightfoot (2001)

The value-added ratios used in the earlier study were generally:	Value-Added Ratio
Large-scale offshore fishing	40%–55%
Small-scale commercial fishing	55%–70%
Subsistence	
Non-motorized	90%
Motorized	65%–75%
Aquarium fish	65%
Seaweed cultivation	90%
Pearl culture	80%

Source: Gillett and Lightfoot (2001).

of the Pacific Community (FFA/SPC) DevFish project enjoyed access to financial information at the enterprise level in several Pacific island countries. On the basis of examining records at several longline and purse seine fishing companies, it was concluded that a VAR of 0.20 should be used for the period 2005–2007 for locally based longlining and 0.496 for purse seining. (Philipson 2006, 2007a, 2007b; P. Philipson, personal communication, November 2008). From Smith and Tamate (1999), likely the best source of information for the VAR for industrial pole-and-line tuna fishing, a VAR of 0.60 has been estimated.

Table A3.1: Value-Added Ratios from Recent Studies of Small-Scale Fishing and Aquaculture

Category	Activity and Location	Source and Date	Value- Added Ratio
Non-vessel fishing	Fishing without use of vessel, Niue; using rods from the reef top by walking	Kronen (2007); study carried out May–June 2005	0.92
	Fishing without use of vessel, Pohnpei, Federated States of Micronesia. Fishing activity included mainly (in descending order) spearing, line fishing, and netting	Rhodes et al. (2007); study carried out January 2006– January 2007	0.89
Non-motorized fishing	Non-motorized canoe fishing, Pohnpei, Federated States of Micronesia. Fishing activity included mainly (in descending order) spearing, line fishing, and netting	Rhodes et al. (2007); study carried out January 2006–January 2007	0.91
	Non-motorized canoe fishing, Niue; deep-bottom fishing and/or the use of fishing rods and handlines from non-motorized canoes	Kronen (2007); study carried out May–June 2005	0.95–0.98

continued on next page

Table A3.1: continuation

Category	Activity and Location	Source and Date	Value- Added Ratio
Fishing from small outboard powered skiffs	Tuna trolling from outboard-powered skiffs in Tarawa, Kiribati	R. Stone, Forum Fisheries Agency, unpublished data, 2007	0.60
	Outboard-powered fishing with engines 6–40 horsepower, Pohnpei, Federated States of Micronesia. Fishing activity included mainly (in descending order) spearing, line fishing, and netting	Rhodes et al. (2007); study carried out January 2006–January 2007	0.74–0.79
	Small boat fishing in New Caledonia; outboard vessels 3.4–4.5 meters in length	Dupont et al. (2004); data from 2002 to 2004	0.65
	Small boat fishing in New Caledonia; outboard vessels 5.5–5.5 meters in length	Dupont et al. (2004); data from 2002 to 2004	0.80
	Motorized skiff fishing, Niue; using motorized boat transport for deep-water and pelagic fishing	Kronen (2007); study carried out May–June 2005	0.61–0.72
	“Artisanal fishing” in Fiji Islands	Reddy (2004); data from June 2003 to January 2004	0.51
Fishing from vessels larger than 7 meters	Small boat fishing in New Caledonia; inboard vessels 7–8 meters in length	Dupont et al. (2004); data from 2002 to 2004	0.65
	Small boat fishing in New Caledonia; inboard vessels 8.4– 12.0 meters in length	Dupont et al. (2004); data from 2002 to 2004	0.60
	Alia longline fishing in Samoa; Apia-based	Hamilton (2007); data from 2006	0.47
	Alia longline fishing in Samoa; rural Upolu-based	Hamilton (2007); data from 2006	0.48
	Alia longline fishing in Samoa; Savaii-based	Hamilton (2007); data from 2006	0.39

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Table A3.1: continuation

Category	Activity and Location	Source and Date	Value- Added Ratio
Aquaculture	Tilapia farming model developed for the Pacific islands, 2-pond farm (20x30 m), mill mix feed	Secretariat of the Pacific Community, unpublished data	0.74
	Large-scale pearl culture in Fiji Islands	J. Hunter (Personal communication, November 2008)	0.45–0.51
	Pearl culture in the Cook Islands, 30% technician paid locally	R. Newnham (Personal communication, October 2008); 2005 and 2006	0.41 (2005) 0.21 (2006)
	Pearl culture model developed for medium-sized pearl farm in Kiribati	Secretariat of the Pacific Community, unpublished data	0.69
	Live rock culture in Fiji Islands	Lal and Cerelala (2005); data for 2000–2004	0.40
	Seaweed culture in the Solomon Islands.	Cospi (2007).	0.72
Others	Coral harvesting in Fiji Islands	Lal and Cerelala (2005); data for 2000–2004	0.70

Source: Sources are shown in the table.

Value-Added Ratios Used in this Report

In view of the above studies and experience gained from Gillett and Lightfoot (2001), in this report the VARs in Table A3.2 are generally used. Some judgment is, however, required in using the VARs. Depending on the national situation, the mix of fishing activities, and associated intermediate costs of those activities, the VARs used herein vary somewhat from Table A3.1.

Table A3.2: Value-Added Ratios Used in this Report

Category of Fishing/ Aquaculture	Specific Type	VAR
Offshore tuna fishing	Locally based longlining	0.20
	Locally based purse seining	0.50
	Locally based pole-and-line	0.60
Coastal commercial and subsistence	Fishing without a boat	0.90
	Fishing in non-motorized canoe	0.92
	Fishing with small outboard boat	0.60–0.80
	Tuna trolling	0.60
	Alia longline fishing	0.47
Aquaculture	Pearl culture	0.45
	Tilapia culture	0.74
	Seaweed culture	0.72
	Coral culture	0.40
Other	Coral harvesting	0.70
	Aquarium fish collection	0.65

Source: Consultant's estimates.

APPENDIX 4

Preliminary Assessment of the Effects of Climate Change on Fisheries and Aquaculture in the Pacific

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Introduction

This brief report outlines how the climate of the Pacific is projected to change, how climate change has affected fisheries elsewhere in the world, and how it is expected to affect fisheries and aquaculture in the Pacific. The emphasis is on the implications for economies of Pacific island countries and territories (PICTs). It concludes with general recommendations that should help the regional and national management agencies and other stakeholders in fisheries to adapt to maintain the benefits of fisheries.

The assessments of the projected effects of climate change, and the recommended approaches for adaptation, are preliminary. They are derived from the early phases of a major regional project to assess the vulnerability of fisheries and aquaculture in the Pacific to climate change coordinated by the Secretariat of the Pacific Community (SPC) and supported by the Australian Agency for International Development (AusAID).[10] The project is due to be completed by mid-2010 and will deliver a much more comprehensive assessment of likely impacts, practical adaptations, and investments needed to address key gaps in knowledge.

Changing Climate and Ocean

The build-up of carbon dioxide (CO_2) and other greenhouse gases in the atmosphere due to human activities is acting in two major ways that will ultimately affect fisheries and aquaculture in the Pacific—global warming and ocean acidification.

The accumulation of greenhouse gases is trapping more of the heat that previously escaped from the earth, leading to an overall increase in average global temperature (Meehl et al. 2007). For the low emissions (B1) and high emissions (A2) scenarios outlined in the 4th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2007), the projected increases in surface atmospheric temperature in the Pacific region by 2035 range from 0.5^0C to 0.8^0C, but to increase considerably for both the B1 and A2 scenarios by 2100 (Table A4.1). The oceans will absorb much of this heat. Thermal expansion of the oceans, together with melting of glaciers and land ice, results in a rise in sea level, which is projected to increase by up to 50 cm by 2100 under the A2 scenario (Table A4.1). However, this may well be an underestimate due to accelerated melting of land ice (Bindoff et al. 2007).

10 For details see www.spc.int/sppu/index.php?option=com_content&task=blogcategory&id=1&Itemid=80

Increases in ocean temperature also make the surface waters more stable, reducing vertical mixing and the availability of nutrients in the upper level of the ocean. Reductions in the supply of nutrients limit the primary production at the base of the food chains supporting fisheries.

A warmer global climate also causes changes in atmospheric and oceanic circulation patterns, giving rise to regional changes in climate. Tropical cyclones and anticyclones are a major source of disturbance to coastal environments in the tropical Pacific and although there may be fewer of them in a warmer world, those that do occur are likely to be more intense, resulting in rougher seas, more powerful waves, stronger winds, more intense rainfall, and greater localized destruction (Poloczanska et al. 2007; CCSP 2008; Fabricius et al. 2008). As tropical oceans warm, there will be greater evaporation and moisture availability, leading to an intensification of the hydrological cycle and expansion of the Hadley Circulation in the Pacific. Total rainfall is projected to increase in the tropical Pacific between 10°N to 10°S and decrease in the subtropics (Table A4.1).

El Niño–Southern Oscillation (ENSO) events are the major source of interannual climate variability in the region, with distinct oceanographic, temperature, rainfall, and cyclonic conditions associated with the two phases: El Niño—when the equatorial divergence is located well to the east of the Pacific, and surface waters are warmer than usual, and La Niña—when the equatorial divergence occurs across much of the region and temperatures are cooler. The divergence brings nutrient-rich waters to the surface and enhances the production of phytoplankton and zooplankton that supports fisheries. Global climate models do not, at present, provide a consistent picture as to how the occurrence, intensity, or frequency of ENSO events might change with continued global warming. However, they do indicate that ENSO events will continue to be a dominant feature of Pacific climate for the foreseeable future.

In addition to changing atmospheric and oceanic climates, the increased burden of the main greenhouse gas, $CO_{2,}$ is changing ocean chemistry, a process called ocean acidification (Hoegh-Guldberg et al. 2007). The ocean has absorbed about a third of the human CO_2 emissions since around 1750 and it is now more acidic than at any time during the last 650,000 years (Orr et al. 2005). This effect is largely independent of global warming and has grave consequences for marine life. The dissolved CO_2 reacts with seawater to form weak carbonic acid, which reduces availability of the dissolved carbonate required by many marine calcifying organisms to build their shells or skeletons (Poloczanska et al. 2007; Guinotte and Fabry 2008). There is serious concern that continued emissions of CO_2 will drive sufficient gas into

Table A4.1: Projected Changes in Pacific Climate and Oceans Relative to 1980–1999 Levels, and Projections of Total Concentration of Atmospheric Carbon Dioxide

Climate feature	Low emissions (B1) scenario 2035	High emissions (A2) scenario 2035	Low emissions (B1) scenario 2100	High emissions (A2) scenario 2100
Surface atmospheric temperature (°C)	0.5–0.8	0.5–0.8	1.0–1.5	2.5–3.0
Sea surface temperature (°C)	Sea surface temperature changes are similar to those for surface temperatures though slightly lower in magnitude; there is also a spatial pattern to the projected surface warming with greater warming in the eastern than in the western equatorial Pacific and less warming in southeastern Pacific.			
Sea-level rise (centimeter)[a]	8	8	18–38	23–51
Rainfall	5%–15% increase in tropics, decreases in subtropics	5%–15% increase in tropics, decreases in subtropics	10%–20% increase in tropics, decreases in subtropics	10%–20% increase in tropics, decreases in subtropics
Cyclone frequency and intensity	Cyclones less frequent but more intense. Projected to increase in intensity by 6%–12% by 2100, equivalent to 0.5 of a cyclone warning category.			
El Niño–Southern Oscillation (ENSO)	ENSO events will continue as a source of interannual climate variability, but it is uncertain whether they will increase in frequency or intensity.			
Aragonite saturation levels in ocean	Adequate to marginal for coral reefs	Adequate to marginal for coral reefs	Marginal	Low to risky for coral reefs
Carbon dioxide (parts per million)	~400	~400?	450–500	750–800

[a] Could be underestimates, depending on rate at which land ice and glaciers melt.

Sources: Information on rainfall, temperature, tropical cyclones, and ENSO was prepared for the Secretariat of the Pacific Community project by G.A. Meehl, National Center for Atmospheric Research, USA, following Meehl et al. (2007); sea level from Bindoff et al. (2007), carbon dioxide concentrations from Foster et al. (2007); and aragonite saturation states from Guinotte et al. (2003).

the oceans to cause undersaturation of carbonate. Where this happens, the environment will not favor formation of structures like coral reefs created by animals and plants with carbonate skeletons and shells. The Pacific Ocean is projected to become more acidic by 0.3–0.4 pH units by 2100, reducing the supersaturation levels of aragonite (a form of carbonate) from >4 to 3.0–3.5 by 2070 throughout much of the tropical and subtropical Pacific (Guinotte et al. 2003), causing many coral reefs there to collapse (see Section 4.2).

Some of these projected changes in the climate system are already evident in the observational records. The pH of the oceans has fallen by 0.1, global sea level has risen by ~20 cm, and global average temperatures are now ~0.7°C warmer than at the end of the 19th century (IPCC 2007). Evidence of recent acceleration in the rate of these changes in the physical environment also exists. This rate of change is of considerable concern when considering the impacts of a warming world on natural ecosystems, such as the fisheries of the tropical Pacific. Over the period 1950–2007, global average land and sea temperatures have warmed at 0.12°C/decade and tropical Pacific sea surface temperatures at 0.07°C/decade.

Effects of Climate Change on Fisheries Worldwide

There is broad concern around the world about the effects that future changes to climate will have on fisheries and aquaculture. This concern arises because even recent variations in climate on time scales of years to decades have caused significant variation in fisheries production. For example, catches of Peruvian anchovies varied from < 100,000 tons to > 13 million tons between 1970 and 2004 as a result of changes in ENSO (Brander 2007). Closer to home, the alternate phases of the ENSO cycle largely determine the distribution of skipjack tuna in the western and central Pacific Ocean—they move further east during El Niño years and then follow the warm pool west during La Niña episodes (Lehodey et al. 1997; Lehodey et al. 2003; Loukos et al. 2003). In other cases, abrupt changes in physical oceanography and biology, known as "regime shifts," which can persist for more than a decade, have major consequences for the species composition and productivity of fisheries (Lehodey et al. 2006; Brander 2007). The effects of such shorter-term changes in climate are not always negative—a period of ocean warming around Greenland starting in 1925 resulted in a northern extension in the range of cod by more than 1,000 km and creation of an international fishery of more than 400,000 tons/year (Brander 2007).

In view of these often dramatic effects, fisheries managers are confronted by many important questions. Will the species that currently support fisheries still be available as greenhouse gases increase? If not, which species are most likely to replace them? For those species that continue to support fisheries, will climate change reduce the capacity for replenishment and production and increase the risk of overfishing? What costs will be involved in adapting to harvest fish in different ways? Will fishing at sea become more hazardous?

To answer these questions, concerted efforts in some parts of the world are now documenting how the observed and projected changes to atmospheric climate and the oceans are affecting, or are likely to affect, the distribution and production of fish, and the fisheries that depend on them (Perry et al. 2005; Hobday et al. 2006; Lehodey et al. 2006; FAO 2007; Brander 2007; Johnson and Marshall 2007; Poloczanska et al. 2007; Munday et al. 2008a).

Effects on Distribution of Fish

Alterations to water temperature, depth of the surface mixed layer, and currents occurring as a result of changes in climate are having significant effects on the distribution of both oceanic and coastal fish. The main patterns that have emerged are (i) expanded distributions of warm water fish species toward the poles (Parker and Dixon 2002; Perry et al. 2005), (ii) latitudinal shifts in areas where species occur (Munday et al. 2008a), and (iii) contracted distributions of species adapted to cooler waters (Welch et al. 1998).

Other effects of climate change are also altering the patterns of fish distribution. These include (i) expansion of zones of low productivity (Polovina et al. 2008), which oceanic fish avoid in their search for food; (ii) occurrence of key prey species at increasingly higher latitudes (Richardson 2008), which help support the food chain for oceanic fish where it was inadequate previously; and (iii) changes to the strength of currents, which affect dispersal of fish larvae and connectivity among populations in different areas (Munday et al. 2008a).

Effects on Fish Production

Climate change can be expected to mediate fish production through effects on reproductive success, recruitment processes, and survival and growth of target species and/or their prey. These effects occur both directly, due to inherent sensitivities of marine organisms to changing environmental conditions, and/or indirectly through the influence of climate change on the habitats that support fish or the pathogens that can control their abundance (Brander 2007; Munday et al. 2008a). Collectively, these effects can flow on to fisheries productivity; Klyashtorin and Lyubushin (2005) showed that changes in long-term dynamics of 12 important commercial Atlantic and Pacific fish stocks mirrored long-term changes in sea–air temperature and atmospheric circulation.

Reproduction of fish is often highly sensitive to temperature fluctuations (Munday et al. 2008a) and so warming can have either a positive or a negative effect on egg production, depending on whether the target fish species is close to its thermal optimum. In general, most fishes are strongly adapted to the range of environmental conditions that they experience throughout the year. Rapid or dramatic increases in temperature above normal maximum temperatures are expected to have significant negative effects on overall viability of some fish populations (Munday et al. 2008b).

Interactions between the effects of higher water temperatures, altered currents, and changes to the depth of the mixed layer on the dispersal and survival of larvae (Meekan et al. 2003; Green and Fisher 2004; Poloczanska et al. 2007), are expected to result in new patterns of recruitment. As a result, the areas with the potential to yield the most fish within the distribution of a species can be expected to change. Evidence is also emerging that acidification of the ocean can disrupt the olfactory cues used by fish larvae to settle successfully on coral reefs (Munday et al. 2009), raising concerns that the inherently large variation in recruitment success may become even more extreme. Both effects have implications for fisheries as they can be expected to alter the location of the best fishing grounds.

The area and structural complexity of the coral reefs, seagrasses, and mangroves that provide shelter and food for many coastal fish species are likely to be altered by rising water temperature, acidification of the ocean, more intense cyclones, changes in sedimentation from new patterns of rainfall, and rising sea levels (Poloczanska et al. 2007). The coverage and quality of these key structural habitats have already been reduced dramatically worldwide through the impacts of developments in the coastal zone (Duarte 2002; Alongi 2002). The concern is that climate change will create damaging synergies with localized nonclimate stressors, and exacerbate the problem (Hoegh-Guldberg et al. 2007; Johnson and Marshall 2007).

Increasing temperatures are also expected to have a direct effect on the growth of fish, especially for temperate species in which growth is currently limited by cold winter temperatures (Thresher et al. 2007).

The relative importance of these various processes is yet to be determined. In some locations, the impact of any increased production of existing target species may be overshadowed by the alterations to species composition likely to occur as a result of changes to fish distribution and modification of habitats.

Potential Impact of Climate Change on Fisheries and Aquaculture in the Pacific

Preliminary assessments indicate that the oceanic, coastal, and freshwater fisheries and aquaculture operations of the Pacific will be as equally subjected to the direct and indirect effects of climate change as fish resources elsewhere in the world. A summary of the main potential positive and negative effects of climate change on fisheries and aquaculture in the region is provided below.

Changes to the Distribution and Abundance of Tuna

Alterations in ocean temperatures and currents, and the food chains in the open ocean, are projected to affect the location and abundance of tuna species (Lehodey et al. 1997, 2003; Loukos et al. 2003). Initial modeling indicates that the concentrations of skipjack and bigeye tuna are likely to be located further to the east than in the past (Lehodey et al. 2008a, 2008b; Lehodey et al., in press). The simulations have yet to be done for yellowfin and albacore.

Although the current patterns of abundance of tuna are mediated strongly by ENSO (Lehodey et al. 1997), the quantities of tuna likely to be available to each PICT during El Niño and La Niña events are relatively well understood and are used by PICTs in consultation with regional agencies to plan contributions to economic growth through provision of access rights to distant-water fishing nations (DWFNs). They are also taken into account in proposals to attract investments to develop domestic fishing fleets and to establish local canneries, loining plants, and export businesses.

Significant changes to the distribution of tuna will make the exclusive economic zones (EEZs) of some PICTs more, or less, attractive to DWFNs engaged in the surface fishery for skipjack tuna, with consequences for national gross domestic product (GDP). As it stands, revenues from the sale of fishing rights for tuna currently make up a far greater proportion of GDP in some of the smaller PICTs in the central Pacific (e.g., Kiribati, Tuvalu, Tokelau) than they do for many countries further to the west (Table 26.7 in main report). Displacement of tuna stocks further east in the Pacific would be a windfall for these PICTs because they currently have few other options for generating national income. Their GDP would increase substantially in relative terms, especially if prices increase due to depressed catches elsewhere in the world.

Reduced demand by DWFNs to fish for skipjack tuna within the EEZs of PICTs in Melanesia will have a far lower impact on their GDP in relative terms because revenue from access fees currently makes only a minor contribution to their larger economies (Table 26.7 in main report). Nevertheless, there will be substantial losses in real terms given the large quantities of tuna currently caught there, particularly during La Niña episodes. The negative effects on other PICTs in the western and central Pacific (Federated States of Micronesia, Nauru) are likely to be more severe.

The consequences of skipjack tuna moving further east over time may have some negative effects on the viability of canneries in the western Pacific. Currently, the canneries in Melanesia use fish caught within their EEZs and pay about \$150/ton less for fish than their competitors in Thailand, which have to meet higher costs for the delivery of their raw materials. However, if the canneries in Melanesia have to source some of their fish from further east, this comparative advantage could be reduced substantially because the costs per ton for delivery are not directly proportional to distance; there is a large fixed cost for charter and demurrage.

Another consequence of skipjack tuna moving further east is that operators in the fishery in the Philippines, which is already heavily exploited and has some overcapacity, will seek to follow the resource. Because the Philippine industry usually operates close to shore bases, this may provide opportunities for, or conflict with, plans by PICTs to domesticate the tuna sector.

The changes in the distribution of skipjack tuna will happen progressively over many years, giving the industry time to adapt. A potential complicating factor is the specter of future rises in the cost of fuel. This subject is covered in Appendix 5.

Identifying the preliminary implications of climate change for longlining operations is not practical at this stage because although initial simulations indicate that there will also be an eastward shift in adult bigeye tuna (Lehodey et al. 2008), modeling for yellowfin tuna and albacore is not yet available. Given the great value of the longline fishery, and the fact that it is the main way that tuna currently contribute to the economic growth of PICTs in the south and east of the region, this modeling effort should be done as a matter of urgency.

The plans to use tuna to help meet the emerging need for fish for food security in the Pacific (SPC 2008a; Bell et al. 2009) could be more difficult to implement in Melanesia as a result of climate change. These plans include (i) selling tuna of low export value on local markets to provide fish for the urban poor; and (ii) establishing low-cost, inshore fish aggregating devices (FADs) in rural areas to improve access to tuna for subsistence fishers.

Projections that cyclones will become progressively more intense may increase the risk of damage to shore-based facilities and fleets for domestic tuna fishing and processing operations in PICTs located within the cyclone belt. For all PICTs, rising sea level will eventually make many of the existing wharfs and shore-based facilities unusable. Careful planning will be needed to ensure that future investments in this vital infrastructure are "climate proof."

The fact that cyclones are not projected to become more frequent in the southern Pacific means that there should be little effect on the number of days suitable for fishing at sea. However, the dangers associated with more severe cyclones may require some fleets operating or based in subtropical PICTs to be upgraded to sizes that confer acceptable standards of safety at sea under such conditions.

Taken together, the increased costs associated with repairing and relocating shore-based facilities, and addressing increased risks to occupational health and safety for fishers, will affect the profitability of domestic fishing operations. This will need to be taken into account by PICTs when planning the optimum mix of developing local industries for tuna and providing continued access for DWFNs.

Changes to Coastal Fisheries Production

Significant changes can be expected in the availability and relative abundance of fish and invertebrates that currently support coastal fisheries in the Pacific. Although there is still little certainty about how changes to water temperatures, acidity of the ocean, current regimes, availability of nutrients, and cyclone intensity will affect coastal fish species directly, there is more confidence about how climate-induced changes to their supporting habitats (coral reefs, mangroves, sea grasses, and intertidal and shallow bare sediments) will affect these fish and the fisheries they sustain.

The projected effects of climate change on coral reefs are better understood than for other coastal habitats. Rising sea surface temperatures and more acidic oceans are projected to have increasingly severe impacts on the growth of hard corals. In recent decades, mass coral bleaching—expulsion by corals of the symbiotic algae (zooxanthellae) that provide them with energy—has increased in frequency and severity. For many corals, bleaching occurs when sea surface temperatures exceed the normal maxima by 1°C–2°C for 3–4 weeks. Deprived of their energy source, corals slow their growth, have lower reproduction and become much more susceptible to physical damage, being overgrown by algae and infected by diseases. Periods of extended bleaching result in death of corals. The rate of global warming is projected to outstrip the capacity of many corals in the Pacific to adapt (Hoegh-Guldberg et al. 2007). This is predicted to result in a net loss of structural complexity on coral reefs because the rate at which corals die and erode following bleaching is likely to exceed the rate at which new corals form.

This situation will be compounded by the acidification of the ocean, which reduces the carbonate available for construction of coral skeletons (Hoegh-Guldberg et al. 2007). As the acidity of the ocean increases, the balance between calcification (reef building) and bioerosion of reefs—excavation of coral skeletons by animals like parrotfish, sea urchins, and boring polychaete worms—will be upset, accelerating the collapse of reefs. The growth of some corals in Australia has already begun to slow down due to reduced rates of calcification (De'ath et al. 2009). More powerful waves from stronger cyclones will exacerbate the destruction of reefs in PICTs in the cyclone belt.

Taken together, these aspects of climate change are projected to progressively reduce the biological and structural complexity of coral reefs. A rise of 2°C in water temperature and atmospheric concentrations of CO_2 of 450–500 parts per million (ppm) will eliminate most branching corals and reefs will be dominated by macroalgae. If water temperatures increase by >3°C and CO_2 exceeds 550 ppm, reefs are likely to consist mainly of coral rubble (Hoegh-Guldberg et al. 2007). The onset of such degradation is expected to occur even earlier in places where overfishing removes the herbivores that feed on the algae that normally impedes the growth of coral (Hughes et al. 2003, 2007).

The loss of structural and biological complexity on coral reefs will have profound effects on the types of fish and invertebrates associated with them. Species that depend on live coral for food, and on the intricate variety of shelter created by structurally complex reefs for their survival, are likely to disappear (Wilson et al. 2006; Graham et al. 2006; Pratchett et al. 2008). These coral-dependent and highly specialist reef fishes may be replaced by herbivorous and generalist species, leading to changes in community structure rather than net losses of biodiversity or productivity (Bellwood et al. 2006). However, this simplification of reef habitats will involve the loss of many existing energy pathways and make these ecosystems much more sensitive to future disturbances, including overfishing (Nyström et al. 2008). Effects of climate change on coastal fisheries associated with coral reefs may not be immediately apparent, but result in slow, long-term (decadal) declines in yields as resilience and productivity are gradually eroded.

The demise of coral reefs is not the only factor that will affect coastal fisheries resources. Depending on the location of PICTs, projected increases in temperatures, sea level, cyclone intensity, and turbidity of coastal waters due to higher rainfall, can be expected to affect the growth and survival of mangroves, seagrasses, nonreef algal habitats, and the nature of intertidal and subtidal sand and mudflat areas. Although the role that these habitats play in supporting fisheries production in the Pacific is poorly understood compared to that of coral reefs, there is evidence that the vegetated areas provide important nurseries for juvenile organisms (Coles et al. 1992; Bloomfield and Gillanders 2005), and they all provide important feeding habitats for a wide range of coastal fish species (Coles et al. 1992; MacIntyre et al. 1996a; Bloomfield and Gillanders 2005). Reductions in coverage and structural complexity of the vegetated habitats due to more severe disturbance from cyclones, increased stress from higher temperatures, reduced light levels from more turbid conditions, and increasing sea levels can be expected to reduce recruitment success for many species of fish and invertebrates (Lovelock and Ellison 2007; Sheaves et al. 2007; Waycott et al. 2007; Gilman et al. 2008). Erosion of intertidal flats, and changes to the associated microalgae that drive the high productivity of these areas (MacIntyre et al. 1996b), are likely to occur as a result of more intense cyclones and sea level rise. Such changes can be expected to alter the function of intertidal flats as feeding areas for fish.

Given the vital role that coastal fisheries play in subsistence throughout the Pacific (Dalzell et al. 1996; SPC 2007a, 2008a; Bell et al. 2009), one of the greatest impacts that climate change is likely to have is on food security. If future production of fish from coral reefs and other coastal habitats decreases, or is comprised of fish not readily accepted as food by local communities, the emerging gap in the fish needed for food security will increase. This will place even more pressure on governments to allocate an increasing proportion of their tuna resources for local food security.

The effects of climate change on valuable invertebrate export commodities, such as trochus and bêche de mer, have yet to be determined. On the one hand, increased acidification of the ocean could affect the survival of trochus by making their shells significantly weaker and by increasing their exposure to predators during their vulnerable juvenile stages. Similarly, the growth and survival of bêche de mer could be impeded by poorer development of their spicules (Kinch et al. 2008). On the other hand, it is possible that the predators of these valuable invertebrates could be reduced and algal food sources enhanced by climate change. Any such effects will be difficult to determine in many countries due to chronic overfishing. Management must strive to rebuild viable spawning stocks so that these resources not only deliver more benefits, but are more resilient to adverse conditions and able to take advantage of any favorable changes to their ecosystems.

There is a reasonable risk that the projected changes to coral reefs and the fish and invertebrates associated with them will make it more difficult to supply the diverse range of organisms demanded by the marine ornamental trade (Warbitz et al. 2003). However, the progressive nature of these changes should enable enterprises to adapt. The industry, which employs hundreds of people in Fiji Islands alone, has proved to be responsive to substantial recent changes in the market place. Therefore, it should be able to capitalize on any opportunities to supply valuable species favored by climate change, or to culture selected popular species no longer readily available in the wild.

Changes to Freshwater Fisheries Production

The imprecision of the estimates of production and value of freshwater fisheries in the Pacific documented in this report underscores the need for a more thorough understanding of the benefits of these resources to local economies. Native and introduced freshwater fish and invertebrates may be making greater contributions to fishery catches than governments appreciate. In particular, freshwater fish and invertebrates may be providing much of the animal protein in large areas of inland Papua New Guinea (PNG). The quantities consumed have yet to be confirmed. The potential importance of freshwater resources is evident in the Sepik River catchment, PNG, where more than 350,000 people live and at least 15 species are caught for food, several of which were introduced for this purpose (Coates 1987; Dudgeon and Smith 2006). A range of freshwater species (e.g., tilapia, *Macrobrachium* prawns, and mussels) are also harvested regularly from lakes and rivers elsewhere in the region. Future household income and expenditure surveys in these countries need to be modified to quantify the contribution of freshwater resources to the national diet (Bell et al. 2008).

In PNG, freshwater fisheries resources also contribute to employment. Even in highland areas where fish stocks are very poor, over 50% of the population engages in fishing activities in many areas, traditionally for eels but more recently for several exotic species also (Coates 1996). In the Fly River, there are plans to harvest about 5,000 tons of freshwater herring per year to produce fishmeal for aquaculture and animal husbandry.

The freshwater fisheries of PNG are based on a broad range of river channel and floodplain habitats, fed by some of the highest levels of rainfall on earth. The cycles of flooding not only govern the life cycles of the fish in these habitats but also how, where, and when people can fish. The projected increases of rainfall in the tropics of 5%–15% by 2035, and 10%–20% by 2100 (Table A4.1) are expected to increase the extent and duration of inundation. The effects of increased flooding and higher water temperatures on the fish themselves, and the vegetated lowland areas that support them, have yet to be determined. This must be done quickly so that the species likely to be favored or disadvantaged by the changing conditions can be determined, and the implications for food security and development of enterprises identified.

Increased flooding and warmer water is also expected to enhance the ability of some exotic species to colonize PNG from Irian Jaya. This has already happened in the case of the snakehead. Where the new exotic species are accepted well as food and do not displace valued indigenous species, this will benefit households. Where undesirable fish invade, communities will need to be given options to derive other benefits from them, e.g., as ingredients for feeds for poultry, pigs and small pond aquaculture.

Freshwater fisheries throughout the region are based largely on species that migrate between the sea and freshwater. The combination of rising sea level and changes in rainfall and runoff is likely to affect habitats and fisheries in both estuarine and freshwater reaches of the region's river systems. Small changes in either rainfall or sea level may have major impacts on the ability of fish to move between estuaries and freshwater, affecting nursery ground function (Sheaves and Johnston 2008). These effects also need to be evaluated quickly to determine the potential implications for fishery production, food security, and livelihoods.

Effects on Aquaculture

The latest SPC Aquaculture Action Plan (SPC 2007b) indicates that small pond aquaculture has potential to provide fish for future food security in the region. Analyses of where such production is likely to be practical and cost-effective, and investments in launching the necessary research and development, will need to be made in the near future if this relatively simple form of aquaculture is to make a significant contribution to food security by 2030.

Tilapia is arguably the easiest species to produce in small ponds, and the introduced freshwater fish species with the broadest appeal in the Pacific. Increasing surface temperatures should enable tilapia to be grown at increasingly higher altitudes in PNG. Provided systems can be developed to distribute fingerlings effectively to remote areas, and suitable feeds based on local ingredients can be formulated, small pond aquaculture has potential to progressively contribute much-needed animal protein in inland PNG and on high islands elsewhere in the region. Heavier rainfall in low-lying tropical PICTs may increase the area suitable for rainfed pond aquaculture. However, increased levels of rainfall, particularly if it occurs as heavier events, will increase the risks in lowland areas. These risks would include losing fish from ponds during floods, invasion of ponds by unwanted species, and damage to ponds through infilling and breaching of walls.

Emerging plans to develop cage culture of fish in coastal waters will need to consider the increased risks to investments in infrastructure due to more severe, albeit less frequent, cyclones in those PICTs in the cyclone belt. In tropical PICTs, the possible beneficial or adverse effects of warmer water temperatures on growth and the incidence of diseases will need to be assessed.

The range of aquaculture commodities being developed in the region to support sustainable livelihoods (SPC 2007b) will also be affected by climate change. Preliminary assessments of some of the impacts are summarized below.

Pearl farming faces risks from increased acidification of the ocean. As aragonite saturation levels fall (Table A4.1), the shells of blacklip pearl oysters will be weaker. This is likely to lead to higher rates of predation of juveniles and lower rates of collection of wild spat. Large-scale farms may be forced to rely more heavily on hatcheries to produce spat, increasing production costs. It also remains to be seen whether acidification will impair the ability of pearl oysters to form nacre. If so, pearl quality may decline progressively, reducing the value of pearls produced in the future. More severe cyclones can be expected to increase the risk of damage to the infrastructure of pearl farms in subtropical PICTs.

The "winter syndrome" disease currently causing problems in the production of blue shrimp in New Caledonia may ease with the changing climate. Increases in water temperatures and in salinity of ponds as a result of the reduced rainfall projected to occur in subtropical areas could progressively reduce the occurrence of conditions favored by the pathogen. These are complex issues, however, and it is difficult to predict how shrimp pathogens may respond to these projected temperature and salinity increases, not only in winter but also at the height of summer. Warmer temperatures may also extend the duration of the present single-cycle shrimp growing season and allow production of warmer-water species, such as *Penaeus monodon*.

Climate change may affect the viability of farming seaweed (*Kappahycus* or "cottonii") over the longer term. As a general rule, conditions that cause coral bleaching are also bad for *Kappaphycus*. Higher water temperatures combined with lowered salinity are factors linked to outbreaks of epiphytic filamentous algae (EFA) and "ice-ice" disease that reduce production of *Kappaphycus* (Ask 1999). In more tropical high-island countries, increases in total rainfall will render fewer locations suitable for culture. As coral reefs degrade and herbivorous fish become more prevalent (see Section 4.2), the risk of losses of cuttings and crops to such fish, already a problem at some sites, may increase further.

Warmer water temperatures, increased acidification and more severe cyclones can also be expected to influence the development of aquaculture for marine ornamental products. Village-based farmers in tropical PICTs growing corals and giant clams will face the risk of increased losses due to bleaching, whereas those in subtropical areas will incur greater risks to equipment and loss of stock from rougher sea conditions associated with more intense cyclones. Larger-scale investors able to operate hatcheries in sheltered locations may benefit from market opportunities as sought-after specimens become scarcer in the wild due to degradation of coral reefs. Ultimately, however, the viability of such operations will depend on their capacity to compete with the enterprises culturing ornamentals emerging in Asia.

Adaptations to Maintain the Benefits of Fisheries and Aquaculture

In a changing world, both industry and communities will need to adapt past practices to maintain the benefits from fisheries, and to take advantage of new opportunities emerging from altered resources. One of the keys to successful adaptation will be diversification—the more options that industry and communities have to produce, process, and distribute fish, the greater the chance that some of them may be favored, or not affected, by climate change.

To maintain the benefits of skipjack tuna in the face of redistribution of the stock, PICTs in the western Pacific will need to develop ways to add more value to the lower fish catches projected for their EEZs. Adaptations that promote successful domestication of the industry will be important. Displacement of tuna further east will automatically confer more options to the PICTs there. They will need to undertake thorough analyses to identify the most practical and profitable mix of domestication and access to DWFNs, and the adaptations needed to implement their selected strategies.

For the longline industry, warmer water temperatures and altered ocean currents may change the location of the most profitable fishing grounds, and the composition and abundance of bycatch species. If so, gear and baits may need to be adapted to exclude unwanted, or attract desirable, species.

Ways that coastal fishing communities can diversify their production to continue to catch the quantities of fish they will need for food security include the use of low-cost inshore FADs to provide better access to tuna, and development of small pond aquaculture to supply fish when it is too rough to fish at sea (SPC 2008a, 2008b). However, these simple production methods cannot provide improved access to fish everywhere in the region. Coastal communities may be grouped into seven broad vulnerability categories based on their needs and potentials to adapt in these ways (Table A4.2).

Investments in understanding where and how the vulnerability of coastal communities to shortages of fish can be reduced through diversifying their production will not only help build resilience to climate change, it will also help these communities cope with disasters, such as tsunamis. In cases where it will remain difficult to diversify the production of fish, governments will need to place more emphasis on other aspects of the broader livelihood approaches required to build resilience to shortages of food, e.g., development of "climate ready" crops and plant varieties to diversify local agricultural production systems (SPC 2009).

Another key way of adapting coastal fisheries to provide future food security will involve development and uptake of methods to increase the shelf life of tuna when large catches are made around FADs. This will be particularly important in PICTs where the occurrence of tuna is projected to become more sporadic.

The general approach outlined for diversifying production, processing, and distribution of fish in coastal areas can also be applied to inland communities dependent on freshwater fisheries. However, their options may be largely limited to development of pond aquaculture in ways that can withstand increased risks of flooding.

Table A4.2: Vulnerability Categories of Coastal Communities to Future Fish Shortages

Vulnerability Rating (increasing)	Coastal Fisheries Expected to Meet Future Demand	Area Suitable for Anchored, Inshore Fish Attraction Devices (FADs)	Area Suitable for Pond Aquaculture
1 Very low	✓		
2 Very low to low	X	✓ *	✓
3 Low	X	✓ **	✓
4 Low to medium	X	✓ *	X
5 Medium	X	✓ **	X
6 High	X	X	✓
7 Very high	X	X	X

* FADs anchored in depths of < 500 meters and within paddling distance by canoe, i.e., within 2 kilometers of the coast.

** Boat and motor needed to reach FADs anchored in depths of < 1,000 meters within 6 kilometers of the coast.

Source: Secretariat of the Pacific Community.

Owing to the fledgling status of much of the aquaculture in the Pacific (Bell and Gervis 1999; SPC 2007a), policy makers and planners need to consider not only the impacts of climate change on aquaculture as it is now, but also on how it may evolve in the future. There is much room for flexibility in the way this sector develops. Aquaculture itself promises to be a tool for adaptation to some of the impacts of climate change on fisheries.

Gaps in Knowledge and Priority Activities

In preparing this preliminary report, it was evident that there are many gaps in the knowledge required to make sound projections about the likely effects of climate change on fisheries and aquaculture in the Pacific. Investments are needed to fill these gaps so that future assessments can be made with greater confidence. A preliminary list of the key activities that need to be supported is set out below.

- High-quality observations of surface weather for PICTS and oceanographic conditions in the Pacific. These observations are needed to detect the nature of a changing climate and Pacific Ocean and the significance of their linkages to the region's ecosystems.
- Down-scaling of climate change and oceanographic modeling to the scales of islands. This will allow more rigorous assessment of local sensitivity and vulnerability of PICTs to a changing climate and ocean.
- Improved modeling of the responses of tuna to climate change, including yellowfin tuna and albacore. Future models should incorporate projected fishing effort and interactions between tuna species. They will also require descriptions and long-term observations of the macrozooplankton and micronekton that provide food for tuna between a depth of 1,200 m and the surface to quantify accurately the link between production in the photic zone and tuna abundance.
- Identification of areas likely to be suitable for diversifying coastal and/or freshwater fisheries production through the establishment of low-cost inshore FADs and/or small pond aquaculture.
- Scaling-up regional research facilities to support key experiments and fieldwork on coastal habitats and climate change. Examples of such research include (i) evaluating whether dissolution of coral reefs due to decreasing pH will be ”capped” at local scales through

buffering by the dissolved carbonate, and (ii) assessing the effects of rising temperature and pH on coral reef fish and invertebrate species important for food security and aquaculture.

- Inventory of vegetated coastal habitats, including their connectivity to coral reefs, environmental thresholds for growth and survival, and links to fisheries productivity.
- Research and modeling to assess (i) the habitat and freshwater flow requirements, and connectivity needed to sustain riverine and estuarine fisheries in PICTs; and (ii) projected changes in the area and availability of floodplain habitats for fisheries production, and for pond aquaculture. This will allow better assessment of possible changes in production and species composition of freshwater fisheries resources and the potential for lowland small pond aquaculture, under climate change.
- Assessment and monitoring of the size and composition of coastal and inland fishery landings across the region to assess changes in catch resulting from climate change, and the success of adaptations to retain the benefits of fisheries.
- Investigations of the risk of increased incidence of pathogens for important aquaculture species, such as pearl oysters, shrimp, and seaweed during climate change.

APPENDIX 5

The Energy Costs and Fishing Study

James Wilson and Mike McCoy

This appendix summarizes the findings of the Energy Costs and Fishing Study (published by the World Bank[11]) commissioned as part of the present study. The Energy Costs and Fishing Study assesses the direct impact of fuel price fluctuations on ongoing fishing operations of domestic fishing fleets in Pacific island countries and territories (PICTs), covering both changes in the financial performance and operating patterns. The study includes analysis of fuel supply arrangements (prices, sources, infrastructures), fuel consumption characteristics of the main fleets, and changes in product. The field work for the study was carried out in September–October 2008.

Fuel Supply Markets

Almost all fuel for domestic fleets and locally based foreign fleets in the Pacific is supplied via domestic bunkering. Fuel is sourced through established global distributors who stock in-country tank farms that they themselves usually

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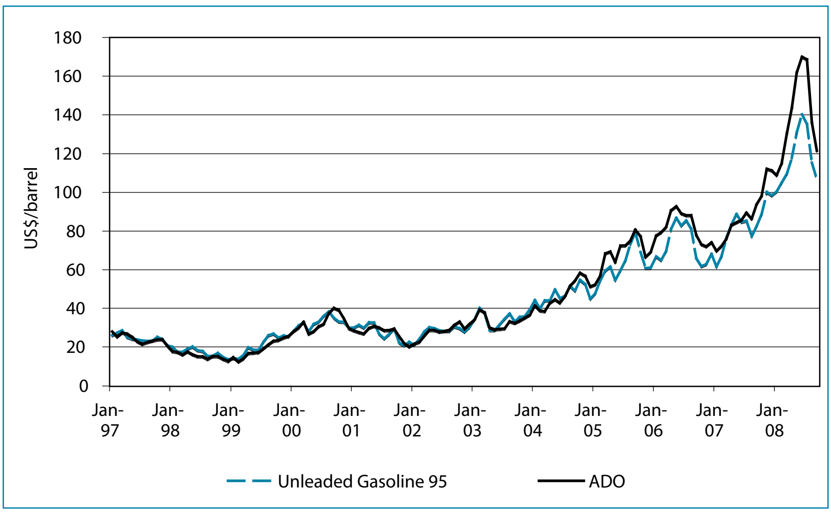
11 Wilson, J., and M. McCoy. 2009. *Study of the Impact of Energy Price Fluctuations on Fisheries in the Pacific, with Emphasis on the Tuna Industry.* Washington, DC: The World Bank.

own. From here, fuel is supplied to the fishing industry either via public fuel wharfs, company fishing wharfs, or normal retail outlets. In general, the market for fuel in the region is small, fragmented, and diffused and countries suffer from negative economies of scale, made worse by the very small number of suppliers.

High seas and EEZ purse seine fleets are normally able to bunker at sea, thereby avoiding some commercial margins and any national taxes. High seas bunker is normally only possible for heavier fuel grades, which are not suitable for small-engined vessels, such as domestic longliners. Under exceptional conditions, domestic companies have been given concessions to bring in their own fuel for their own consumption, at a savings of around 6%. All domestic bunker fuel is supplied as automotive diesel oil (ADO), the regional market being too small for suppliers to consider offering other heavier (and cheaper) grades of fuel.

The largest component of domestic fuel price, the international bulk price, rose dramatically over the past 10 years from under $20 per barrel for diesel in 1998 to a peak of $170 per barrel mid-2008 (Figure A5.1).

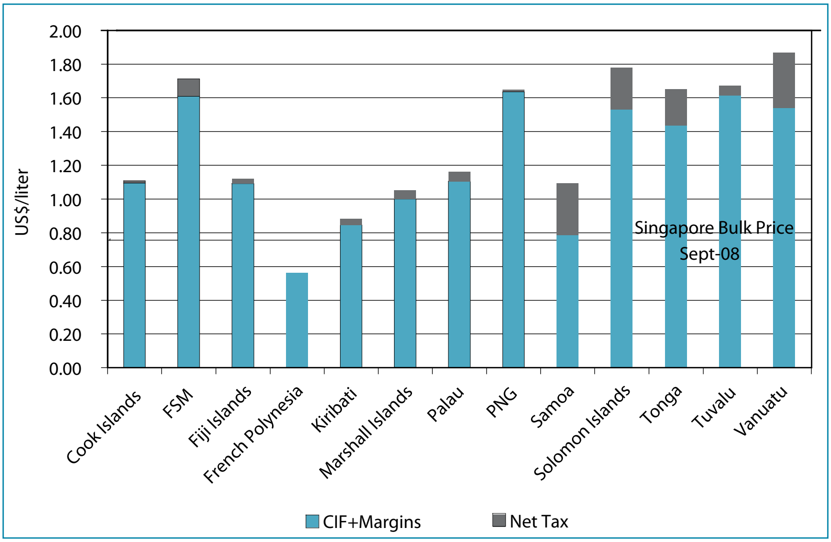
Figure A5.1: International Bulk Fuel Price



ADO = automotive diesel oil, Jan = January.

Source: Wilson, J., and M. McCoy. 2009. *Study of the Impact of Energy Price Fluctuations on Fisheries in the Pacific, with Emphasis on the Tuna Industry.* Washington, DC: The World Bank.

Figure A5.2: Cost of Fuel in Countries of the Region



FSM = Federated States of Micronesia, PNG = Papua New Guinea, Sept = September.

Source: Wilson, J., and M. McCoy. 2009. *Study of the Impact of Energy Price Fluctuations on Fisheries in the Pacific, with Emphasis on the Tuna Industry*. Washington, DC: World Bank.

At the time of the study, the Singapore spot price for ADO was $0.76 liter, while the average price paid by the fishing industry (among the countries for which data were collected) was $1.33/liter, of which $0.11/liter was tax. Significant variations in fuel prices existed between countries, the lowest being in French Polynesia ($0.56) and the highest in Vanuatu ($1.87). Taxation rate varied from -34% (subsidy) in French Polynesia to 39% in Samoa. Fuel prices and taxation are summarized in Figure A5.2. Note that data were not obtained from all PICTs and the values were those paid by domestic fleets.

Governments have sought to reduce the impacts of fuel price fluctuations by various measures, some of which have benefited all consumers, while others have been specifically targeted at the fisheries sector. Tax reductions on fuel have been the most immediate and responsive tool used to lessen the impact of price rises and in many PICTs have been specifically targeted at the fisheries industry. The potential for tax reduction is obviously limited to the degree of taxation in each country, and tax cuts will be at the expense of fiscal receipts. In some countries (Marshall Islands, Papua New Guinea [PNG]) tax reductions were planned but enactment was slow or delayed, thereby reducing the impact of the measure.

More favorable supply arrangements have been attempted through (i) the introduction of competitive bidding (Samoa) for bulk supply contracts; (ii) hedging and forward contracts for fuel purchase (Samoa); (iii) control of fuel storage infrastructure (Samoa, Marshall Islands, Federated States of Micronesia), being key to opening up the possibility of alternative suppliers entering the market; (iv) support for the development of a regional bulk purchase arrangement—the arrangement aims to achieve strategic cost reductions by aggregating demand, and although it has the potential of providing some widespread and common benefits (especially to smaller markets), many of the implementation details remain to be developed; and (v) permitting, under exceptional circumstances, individual direct imports of fuel by companies for their own consumption. This is only feasible for larger companies, such as group purse seine operators, with high fuel demand and sufficient financial and technical resources to be able to bring in fuel.

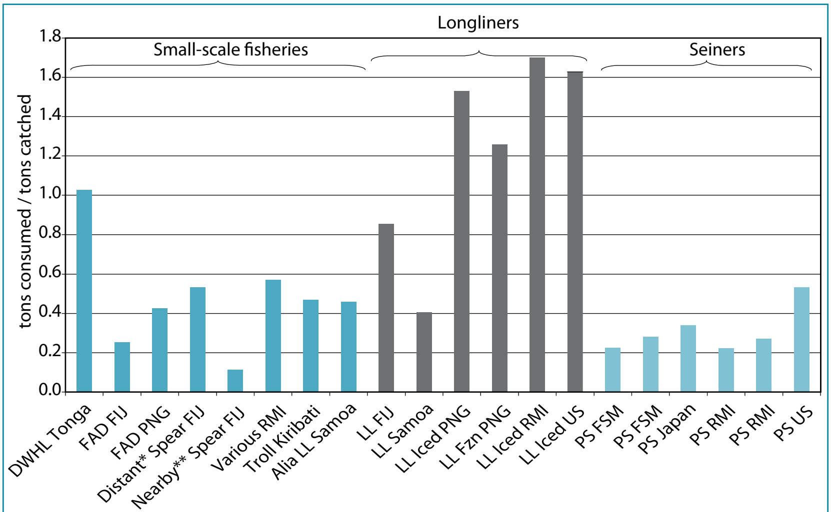
The development of biofuels in the region as a potential alternative energy source has focused on coconut diesel. Although it can be used with few engine modifications (especially if mixed with ADO), the price of biodiesel has also risen along with that of fossil fuels. The potential for production of biofuels is limited in PICTs by access to suitable land, with the exception of PNG. In the future other potential sources of biofuels may include macroalgae.

Exposure to Fuel Price Fluctuations

Exposure to fuel price fluctuations, being the degree to which financial results are affected by fuel price changes, of a selection of fleets in the Western and Central Pacific Ocean (WCPO) was analyzed in terms of the specific fuel consumption (tons of fuel consumed per ton of catch) and a valued version of the same indicator, the cost of fuel consumed per dollar of catch value. The specific fuel consumption is a factor of fishing method, proximity to grounds, operational arrangements, onboard catch preservation, speed, maintenance, vessel design, engine size, and resource productivity. Some of these factors can be considered variables and are under the immediate control of vessel operators (such as speed), while others are parameters that are essentially fixed, such as hull form or fishing method. Figure A5.3 shows the specific fuel consumption for a selection of fleets.

Of the cases examined, the consumption of fuel per ton of catch in small-scale fisheries was less that of longliners but about twice as much as seiners. Longliners with on-board freezing do not show significantly higher fuel consumption than those using ice to cool the fish, indicating that both technical (design, machinery) and operational factors play important roles in determining fuel consumption.

Figure A5.3: Fuel Consumption by Fleet



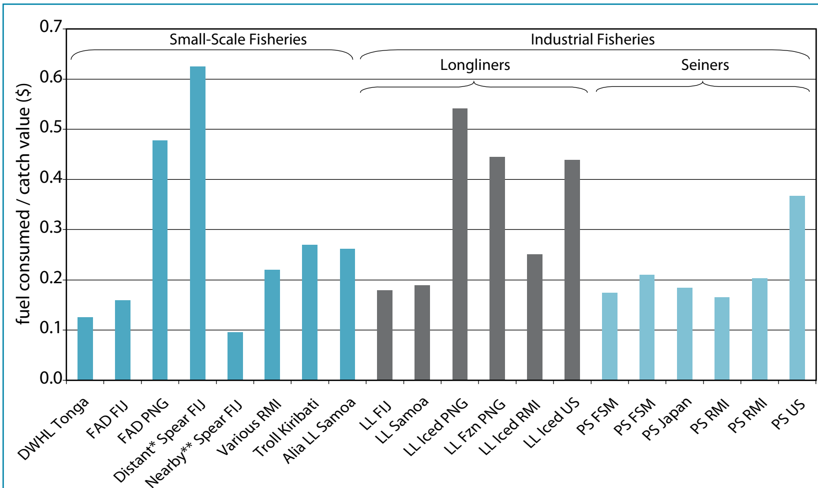
* Urban-based vessels fishing distant grounds.

** Village-based vessels fishing local grounds, including fuel required for marketing.

DWHL = deepwater handline, FAD = fish attracting device, FIJ = Fiji Islands, FSM = Federated States of Micronesia, FZN = frozen, LL = longline, PNG = Papua New Guinea, PS = purse seiner, RMI = Republic of the Marshall Islands, US = United States.

Source: Wilson, J., and M. McCoy. 2009. *Study of the Impact of Energy Price Fluctuations on Fisheries in the Pacific, with Emphasis on the Tuna Industry*. Washington, DC: World Bank.

Figure A5.4: Cost of Fuel Relative to Catch Value



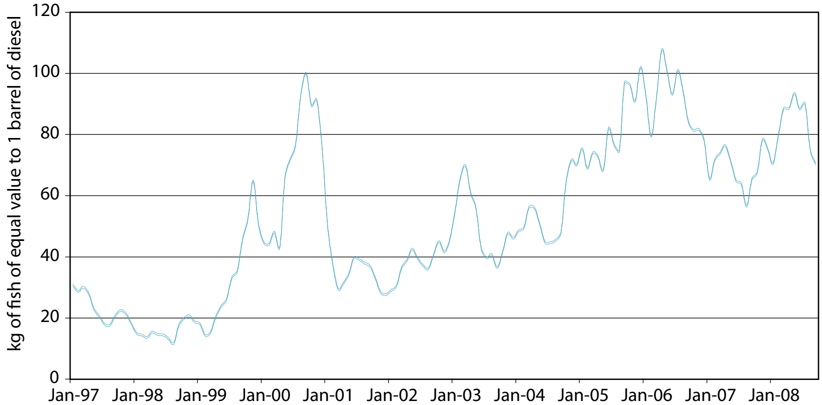
* Urban-based vessels fishing distant grounds.

** Village-based vessels fishing local grounds, including fuel required for marketing.

DWHL = deepwater handline, FAD = fish attracting device, FIJ = Fiji Islands, FSM = Federated States of Micronesia, FZN = frozen, LL = longline, PNG = Papua New Guinea, PS = purse seiner, RMI = Republic of the Marshall Islands, US = United States.

Source: Wilson, J., and M. McCoy. 2009. *Study of the Impact of Energy Price Fluctuations on Fisheries in the Pacific, with Emphasis on the Tuna Industry*. Washington, DC: World Bank.

Figure A5.5: Trends in Fish-to-Fuel Ratio



Jan = January, kg = kilogram.

Source: Wilson, J., and M. McCoy. 2009. *Study of the Impact of Energy Price Fluctuations on Fisheries in the Pacific, with Emphasis on the Tuna Industry*. Washington, DC: World Bank..

The financial exposure linked with specific fuel consumption is illustrated in Figure A5.4, showing the costs of fuel per dollar of catch value. The financial exposure of longliners is still greater than that of purse seiners but the difference is very much smaller than the difference in specific fuel consumption. Artisanal fishers are the most financially exposed of all the fleets analyzed, but with notable variation depending upon operating patterns.

Historical trends in the financial exposure of the main fleets to fuel price fluctuations were examined through the analysis of the terms of trade between fish and fuel. The fish-to-fuel ratio is a measure of the weight of fish catch that is of the equivalent value to the cost of fixed quantity of fuel. In the longline fishery for sashimi grade tuna, this ratio has grown steadily from 1999 to 2008, increasing by a factor of 4.5. In the purse seine fishery for cannery grade tuna, the pattern over the same period is not so simple (as Figure A5.4 shows) and there are peaks in 2000 and 2006 that indicate that during these years, the financial impact of high fuel prices was worse than during the recent peak in mid-2008.

In small-scale fisheries, the same indicator was analyzed for fish landed onto the domestic market in Fiji Islands and showed that the exposure to fuel price had remained relatively constant.

Estimates were made of country exposure to fuel price fluctuations on the basis of updated profit and VARs, declared catches, and the indicators above. Results of exposure to a 5% change in fuel price are presented in Table A5.1. PNG has, by far, the largest national production and would suffer the

Table A5.1: Indicative Country Exposure to Fuel Price Fluctuation (5% change)

	Catch[a]		Change in Profits	Change in Profits per ton	Change in Profits	Change in Value Added
Country	'000 t	$ million	$ million	$/t	(%)	(%)
Cook Islands	2.9	9.7	0.12	42	12	3
Fiji Islands	13.4	45.1	0.41	30	8	2
Federated States of Micronesia	27.8	28.8	0.31	11	3	0
Kiribati	7.1	7.3	0.07	9	2	2
Marshall Islands	41.1	39.2	0.35	9	2	1
Nauru	–	–				
Niue	0.1	0.1	0.00	33	9	1
Papua New Guinea	211.7	228.7	2.34	11	1	0
Palau	–	–				
Samoa	2.5	8.2	0.08	31	9	2
Solomon Islands	24.1	32.2	0.22	9	1	0
Tokelau	–	–				
Tonga	0.8	3.4	0.04	56	15	0
Tuvalu	–	–				
Vanuatu	87.7	122.8	1.28	15	4	0

– = not available, t = ton.

[a] National purse seine + longline fleets.

Sources: Catch and values from Forum Fisheries Agency (FFA); Profit and value-added coefficients from FFA reports.

largest changes in profits and value added. In terms of percentage changes to profit, however, Tonga is estimated as being the most exposed.

The exposure of aquaculture to energy cost fluctuations is very dependent on product and production method. Pearl aquaculture is estimated to consume only about $3 per $100 of product value, considerably less than any capture fishery. Intensive penaeid shrimp aquaculture is estimated to consume 1.7 tons of fuel per ton of product when powered from the mains network—a level similar to that of some longliners. If fuel used in feed production were to be taken into account, consumption would be considerably higher still.

Operational Changes as a Result of Increased Fuel Costs

Changes in operations as a result of increasing fuel costs in the EEZ and/or high seas purse seine subsector have been virtually zero, primarily due to increased dtechnical efficacy and favorable prices for skipjack and yellowfin tuna in world canning markets offsetting the pressure from increased fuel costs. In the same fleet, no significant increases were noted in the number of fish attracting device (FAD)-based sets—a phenomenon that conventional wisdom suggests should accompany fuel price increases. In group purse seine operations (Japanese style) within national EEZs, operational changes were instigated as a result of fuel price increases; these have included shutting down the main engine between sets, reduction of speed, closer monitoring of vessel movement and speed via satellite-based vessel monitoring systems, and reduced reliance on inefficient service vessels that have been converted from old pole-and–line vessels.

Domestic-based longliners have had to face increases in fuel prices together with drops in catch per effort and static product values; the pressure for operational change has been consequently higher than in the purse seine subsector. Changes have included longer trip lengths, a shift toward frozen fish (linked with longer trip lengths), closer vessel monitoring by satellite, consolidation of catches of fresh tuna at sea, concentration on fishing grounds closer to port, reduction of exploratory trips, speed limitation in transit, shutting down main engine and drifting when conditions permit.

In small-scale fisheries, operational changes have included minimization of distance traveled by sea, achieved by moving the operational base nearer to fishing grounds or abandoning distant fishing grounds; changes in fishing method from fuel intensive techniques, such as trolling; and changes in marketing strategy to attempt to maximize value through increased direct sales to consumers.

Market Changes

The principal market for WCPO cannery grade tuna, Bangkok, has shown price increases during 2000–2008, quite similar to those of fuel. Consumer demand has risen, especially in Europe, boosted by the strong euro. In addition, new markets have expanded in South America and the Middle East. Global supply of cannery grade tuna has been down, especially for catch from the Indian Ocean. Newer longliners that supply albacore for canning have the ability to switch to sashimi tuna, further limiting supplies to canneries. Although fish prices have developed favorably, this is *not* considered to be a direct consequence of fuel price increases, but rather favorable market conditions in Europe, helped by preferential trade conditions.

In the markets for sashimi-grade fresh tuna from longliners, there has been little if any positive price development during 2005–2008 in US dollar terms. This is attributed to the economic downturn in Japan, falls in the value of the yen against the US dollar, and the availability of substitute products, such as ultra-low-temperature (ULT) frozen tuna and ranched bluefin tuna.

On the national market in Fiji Islands, supplied by small-scale fisheries, fish prices increased during 2005–2008, in a very similar manner to those for fuel. Although fish price increases lagged those for fuel, both showed similar tendencies and it is reasonable to conclude that production costs, specifically fuel, have had some influence on consumer prices.

Reduction of Exposure to Fuel Price Fluctuations

Vessel-related technical issues that can reduce exposure to energy costs can be grouped under those related to the engine and propulsion and those related to hull form.

Large-scale fisheries:

a. The use of slow or medium-speed diesel engines can bring fuel consumption savings over high-speed engines. The slower revving engines are, however, heavier and larger and only suitable for use in large vessels such as high-seas seiners. In the small-scale fishery, savings could be made through the use of 4-stroke outboard motors instead of 2-stroke. The capital cost, however, is greater for the 4-stroke models.
b. Slow and medium-speed diesels can burn heavier and cheaper grades of fuel, marine gas oil and marine diesel oil, which unfortunately are generally not available in the Pacific region for domestic bunker.
c. Engine capacity should be in keeping with the hull size and application. Excess capacity is common on vessels brought in from other fisheries, such as old pole-and-line vessels currently in use as service vessels in group seine operations or longliners. These vessels usually run at excessive service speeds, under full load of their engines

and propellers; fuel consumption could be substantially reduced if running at more moderate speeds.

d. Hull design parameters as well as the details of external appendages (rudder, cooling tubes) can contribute to fuel savings. These characteristics are either fixed at design phase or can only be changed during a refit.
e. Heat recovery, although still an emerging technology, may offer worthwhile fuel savings in the future through the extraction of energy from the exhaust system and using this for refrigeration via absorption, electricity generation via turbine, and mechanical/electrical power via a combined cycle power plant.

Small-scale fisheries:

f. Correct specification and installation of the propeller and gearbox is essential for an efficient installation. The matching of these components with each other and the engine is particularly relevant after refit or after transferring the vessel to a different application.
g. Alternative fuels may offer savings in the future, but at the moment are not available in sufficient quantities, nor have commercial vessel trials been carried out.
h. The use of sails together with motors in small-scale fisheries can offer considerable fuel savings. However, the equipment is an added expense, takes up space in the boat, and requires adequate structure and hull form and trained and experienced crew. Experience with the re-introduction of sail is not encouraging, as many fishers refuse to use sails when they can use engine power.

Operational issues that can minimize exposure to fuel price fluctuations include the following.

i. Awareness and knowledge is fundamental to fuel saving. The easiest step to take, slowing down, requires self-imposed restraint. Small reductions in speed can yield significant fuel savings. The penalty is more time at sea, possibly less time fishing and/or less time in port between trips.
j. Consolidation of catch, whereby the majority of the fleet remains fishing while one or two vessels bring the catch of the whole fleet to port.
k. The use of FADs eliminates hunting for pelagic fish and increases the likelihood of successful seine sets.

l. Individual fuel supply arrangements, if permitted, can lead to useful savings.
m. Hull and machinery maintenance help to reduce fuel consumption, and should include regular antifouling of underwater surfaces, cleaning the propeller, etc.

Policy options and tools that are relevant for governments to reduce the impact of fuel price fluctuations include the following.

n. Competitive and efficient sourcing of fuel, either through competitive processes or via a regional bulk supply arrangement. The control of relevant infrastructure is very relevant to competitive supply arrangements.
o. Direct impact on operating costs via the adjustment of taxation and excise on fuel. With care, these can be targeted to particular sectors of the economy (if desirable). This has been widely used in PICTs during the recent peak. However, there are potentially negative impacts, including reduction of fiscal receipts, lowering of incentives to use fuel efficient technologies and practices, and suppression of changes in comparative advantage (or lack thereof) and competitiveness of Pacific fisheries.
p. The establishment of fiscal and other incentives to encourage operators to adopt fuel-saving measures or more fuel-efficient fishing technologies, diversify fuel usage, and to raise awareness through education and training.

Recommendations

The Forum Secretariat should reestablish its regional fuel price collection and reporting system.

There is a lack of basic data necessary to monitor the development and impact of fuel prices and availability in the Pacific region. The most basic of these is a mechanism for monitoring long-term fuel price changes on national markets. Previously, this function was performed by the Forum Secretariat through the Pacific Fuel Prices Monitor, but the data have not been updated for several years. Data collection should be integrated, as far as possible, into national government data collection systems and the process of reporting automated, or at least standardized. It is desirable for the system to periodically report in a transparent manner on prices and the tax component, and tax concessions available to particular sectors of the economy.

The fish-to-fuel exchange indicator should be compiled and analyzed on a regular basis.

This tool, illustrating the terms of trade, is useful for tracking the basic financial status of the fishing industry, especially with respect to the impact of changes in relative fuel and fish prices. Compilation and analysis could be made at several levels. At a fleet level, Singapore spot ADO prices could be compared with current market prices from Bangkok (cannery grade) and Japan (sashimi) as has been done in this report. At a national level, achieved export prices could be compared against actual fuel prices charged to the industry, net of any tax or duty concessions. The measure could be used as a tool to indicate when and where interventions, such as the temporary suspension of excise, might be justified. The data required for this exercise are already being collected by some national governments and regional bodies, such as FFA.

Collection of market data for small-scale fisheries should be expanded.

The collection of market data for small-scale fisheries is equally important and only being performed in few PICTs. This information, together with premix or gasoline prices should be collected and used to monitor the fish-to-fuel exchange for important small-scale fisheries. The system needs to be focused on a few relevant markets in order to minimize operating expenses, and could be supported directly by national budgets or via regional organizations.

In the absence of a regional fuel supply arrangement, national governments should continue to promote competitive supply.

Competitive fuel supply is one of the basic mechanisms whereby the impact of changes in energy costs can be lessened. It can be promoted through competitive tendering for supply contracts, regaining or retaining control over key infrastructure, such as fuel wharves and storage facilities, and the establishment of a suitable facilitating regulatory framework.

Change in the basis for fuel taxation should be considered.

National governments should examine the economic and political acceptability of changing the taxation structure on fuel from one based on percentage of value to a fixed rate per unit of quantity. This would reduce the impact of international price fluctuations on fuel prices (to the benefit of both national industrial fisheries as well as national consumers of products from small-scale fisheries). It would safeguard government receipts but be vulnerable to exchange rate fluctuations between national currencies and the US dollar.

Continue the monitoring of the development of alternative fuels, especially coconut biofuel.

The Forum Secretariat should resume the monitoring of the development of biofuels and their markets and serve as a clearing house for published data and research that might allow PICTs to replicate successes from research and development in other parts of the world.

Such support can be provided on a national or regional basis, as developments in alternative fuels may benefit smaller countries through assurance of regional supply in the absence or reduction of imported petroleum-based products. A program to trial such fuel in a commercial fishing vessel should be considered.

Governments should take a more active role in promoting fuel-saving technologies.

Where value-added tax (VAT) and duty are still applied on outboard engines, exemptions should be considered for fuel-efficient (4-stroke) engines when purchased for use in small-scale fisheries. The same should be applied to other equipment specifically targeting improvements in energy efficiency, such as heat recovery. Where either government or the private sector has experimented with innovative fuel-saving mechanisms (such as flapped rudders) results and experience should be compiled and presented in an appropriate public forum.

Governments should consider re-equipment loans to the industry, under preferential terms, to support the installation of modern and more efficient engines.

It is understood that there are rarely discrete funds available for such purposes; however, such institutions as national development banks might be more amenable to such loans if part of an overall government program to reequip and improve the financial viability of the domestic industry. Other avenues, such as allocation of fisheries foreign aid grants, should also be explored for this purpose.

The provision and maintenance of FADs for use by small-scale fisheries should be a priority for national governments in support of domestic fisheries.

The need for FADs to support small-scale fisheries is vital to the maintenance of some specific small-scale fisheries in the region, including those in PNG and Fiji Islands. The need is underscored by the high degree of exposure of such fisheries to fuel price increases and fuel usage.

A focused regional program should be developed to heighten awareness of fuel price impacts and mitigating measures.

The program should be aimed at both government and the private sector to raise awareness of the degree and nature of impacts of fuel price fluctuations in fisheries and the measures that can be taken to minimize them. Such a program might entail organizing meetings and seminars and producing suitable training and informative material.

About Fisheries in the Economies of the Pacific Island Countries and Territories

The fishing industry benefits the people and economies of the Pacific in various ways but the full value of these benefits is not reflected in the region's statistics. Records may be maintained but they are not complete, or accurate, or comparable. The research summarized in this report reaffirms the importance of this sector to the economies and societies of the Pacific island countries. The research reveals that the full value of fisheries is likely to have eluded statisticians, and therefore fisheries authorities, government decision makers, and donors. But its value has never escaped the fisher, fish trader, and fish processor. The difference in appreciation between public and private individuals must raise the question of whether fisheries are receiving adequate attention from the public sector—including the necessary management and protection, appropriate research, development, extension and training, and sufficient investment.

About the Asian Development Bank

ADB's vision is an Asia and Pacific region free of poverty. Its mission is to help its developing member countries substantially reduce poverty and improve the quality of life of their people. Despite the region's many successes, it remains home to two-thirds of the world's poor: 1.8 billion people who live on less than $2 a day, with 903 million struggling on less than $1.25 a day. ADB is committed to reducing poverty through inclusive economic growth, environmentally sustainable growth, and regional integration.

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