Annex A
Economic Valuation of Subsistence Fisheries

Subsistence fisheries play vital roles in the lives of Pacific Island communities. Yet because they are difficult to quantify, they are frequently underrated or absent from national statistics.

Of particular importance to Pacific Island economies is the value of subsistence fisheries in food security. Subsistence fisheries are a major source of animal protein in the diet of Pacific Islanders, and a vital contributor to the nutrition of many coastal communities. Yet resources that are not sold in the marketplace cannot be valued by conventional measures. Instead, an indirect valuation method based on their replacement value could be used. How much would it cost to import substitutes of a similar protein content? And how much would coastal communities need to pay to obtain substitutes with a similar caloric content? This can be assessed by estimating the value of a marketable substitute with an equivalent protein or caloric content. The methodology depends on the existence of nutritional and price data for the most likely substitute in each Pacific Island country which, although anecdotal, is fairly reliable.

At the same time, the valuation depends on the existence of statistics on subsistence catch, and here the data in Pacific Island countries are often questionable. In order to obtain estimates of subsistence catch, surveys need to be performed in coastal communities since subsistence production is not recorded (as in industrial fisheries), or observed in the marketplace (like artisanal production). Because adequate subsistence production surveys have not been performed in most Pacific Island countries, the values given rely on estimates of production based on demographics and consumption patterns, or extrapolations from old surveys. While this probably underestimates subsistence production in many areas where fishing gear and technology have improved since the original surveys were performed, in other areas it may actually overestimate the subsistence catch, as sales of coastal products are becoming increasingly frequent (World Bank 1996). Besides these limitations, the estimates may not reflect the full value of subsistence production to food security in isolated coastal communities. In those areas, likely substitutes (often imported products such as tinned fish) would come at much higher prices than the urban market prices on which this analysis is based. These limitations should be kept in mind when using the results of the analysis.

Methodology

The valuation of the importance of subsistence fisheries for food security involves seven major steps:

- Obtain an estimate of subsistence catch.
- Estimate the contribution of finfish and shellfish to the subsistence catch.
- Account for waste during consumption.
- Estimate the nutritional content – protein and caloric value – of the subsistence consumption.
- Determine the price and nutritional content of the most likely marketable substitute.
- Determine the amount of the substitute that yields an equivalent amount of protein or calories.
- Value subsistence fisheries based on the value of the substitute with an equivalent caloric or protein content.

The protein and caloric content are used to depict two slightly different values: from the point of view of Pacific Island policy makers, it is the protein value of subsistence fisheries that is the most relevant. The question here is how much the country would have to pay to import

substitutes with similar protein content (or, if the country is a net exporter, how much it would stand to lose if it had to divert potential exports to domestic consumption). From the point of view of coastal communities, it is often the caloric value that plays the most important role, since nutritional trade-offs are often made based on what it takes to 'fill the family stomach' (see also World Bank 1996).

- *Step 1. Obtain an estimate of the subsistence catch.* Estimates of subsistence production are commonly found in national fisheries statistics or in statistics from the Food and Agricultural Organization of the United Nations. Whenever possible, the accuracy of these data should be checked against other possible sources such as production surveys.

- *Step 2. Estimate the contribution of finfish and shellfish to the subsistence catch.* Beginning with the estimate for subsistence production, it is necessary to first distinguish the proportion of the production that is made of finfish and shellfish, since each will have a different caloric and protein value. Since this distinction is not generally available in subsistence production surveys or estimates, it can be extrapolated from the composition of domestic commercial inshore fisheries. This assumes that the composition of artisanal production—and hence the ratio of finfish to shellfish—is the same as in subsistence production, which may not hold in cases where the more valuable of the two is sold in local markets. Once a ratio is determined, it can be applied to the total estimate of subsistence production to yield the estimated amount of subsistence shellfish and finfish caught in a given year.

- *Step 3. Account for waste during consumption.* The subsistence production numbers for finfish and shellfish represent whole weights, not all of which are consumed. Since subsistence fisheries are valued in terms of their nutritional contribution, the production must be adjusted to reflect the waste not consumed. For this calculation, it was assumed that 51 percent of the whole weight of finfish would result in waste, while 75 percent of the whole weight of shellfish would result in waste (World Bank 1996). Subtracting the waste from the total subsistence production yields an estimate of net consumption of subsistence finfish and shellfish.

- *Step 4. Estimate the nutritional content of the subsistence consumption.* The nutritional content of the subsistence consumption can be derived from Pacific Island Food Tables (SPC 1994). For finfish, the category "reef finfish" was used. For shellfish, the nutritional content of clams was used to represent the nutritional content of shellfish, as clams are commonly consumed at the subsistence level. These estimates assume that the finfish category in the Pacific Island Food Tables is representative of the average finfish consumed at the subsistence level. The following standard nutritional values were therefore used:

  Finfish—109 kilocalories and 19.5 grams of protein per 100 grams of finfish consumed.

  Shellfish—57 kilocalories and 11.2 grams of protein per 100 grams of shellfish consumed.

  Based on these numbers, the net consumption of finfish and shellfish in kilocalories and grams of protein was derived as shown on Table A.1.

- *Step 5. Determine the price and nutritional content of the most likely marketable substitute.* The most likely substitutes for subsistence fisheries were assessed from knowledgeable country sources. In the Solomon Islands for example, the most likely substitute was considered to be skipjack flakes. In Vanuatu, about 65 percent of the substitute was deemed to be canned mackerel, and 35 percent tinned beef. The substitutes were those most likely to be used by the consumers of subsistence fisheries due to cost, availability, or taste. The prices for substitutes were those quoted for urban markets, which as seen before can be an underestimation of the prices in isolated rural areas. Duties and taxes on marketed

substitutes ─ which should be excluded in an economic valuation─were not taken into account, but they are likely to be small given the recent deregulations in countries like Fiji and Samoa. The nutritional composition of the substitutes used was derived from Pacific Island Food Tables (SPC 1994).

- *Step 6: Determine the amount of the substitute that yields an equivalent amount of protein or calories as subsistence fisheries.* Taking the net nutritional consumption of subsistence fisheries, and dividing it by the nutritional content per weight of the most likely substitute results in the amount of the substitute needed to yield an equivalent caloric or protein content to subsistence fisheries.

- *Step 7: Value subsistence fisheries based on the substitute with equivalent caloric or protein content.* Taking the amount of the most likely substitute necessary to yield an equivalent nutritional content to subsistence fisheries, and multiplying it by the price of the substitute gives the final economic value of subsistence production for food security.

Table A. 1. Estimating the Value of Subsistence Fisheries for Food Security in Selected Pacific Island Countries, 2000

	Fiji	*Kiribati*	*Samoa*	*Solomon Islands*	*Vanuatu*
Subsistence Production					
Finfish Production:	18,057	13,743	4,222	13,564	2,697
Total (in metric tons)	11,015	13,331	2,743	8,817	2,428
Consumed (in metric tons)	5,397	6,799	1,345	4,320	1,190
Kilocalories consumed	5,883,111,500	7,410,463	1,465,723,000	4,709,084,926	1,296,528,731
Grams of Protein consumed	1,052,483,250	1,325,725	262,216,500	842,450,973	231,947,801
Shellfish Production:					
Total (in metric tons)	7,042	412	1,477	4,747	269
Consumed (in metric tons)	1,761	103	369	1,187	67
Kilocalories consumed	1,003,485,000	58,749,900	210,497,580	676,524,450	38,435,471
Grams of Protein consumed	197,176,000	11,543,840	41,360,928	132,931,120	7,552,233
Total Nutritional Content (Finfish and Shellfish):					
Kilocalories consumed	6,886,596,500	66,160,363	1,676,220,580	5,385,609,376	1,334,964,202
Grams of Protein consumed	1,249,659,250	12,869,565	303,577,428	975,382,093	239,500,034
Most Likely Substitute	Canned Mackerel (50%) Canned Tuna (50%)	Tinned Fish	Mutton Flaps (40%) Tinned Herring (60%)	Skipjack Flakes	Canned Mackerel (65%) Tinned Beef (35%)
Total amount of substitute needed:					
In Kilocalories	3,409,206	2,378,730	542,115	3,520,006	754,217
In Grams of Protein	5,812,369	6,078,494	1,415,940	4,064,096	1,255,900
Cost of Substitute (US$ per gram)	0.0012	0.003	0.01	0.003	0.01
Total Value of Subsistence Production (US$ millions):					
In Calories Equivalent	**3.9**	**7.0**	**5.3**	**11.6**	**8.9**
In Protein Equivalent	**6.7**	**18.0**	**13.9**	**13.3**	**14.7**

Annex B
Statistical Tables

Table B.1. Estimated Fishery Production in Pacific Island Countries
(in metric tons)

Country	*Offshore (Industrial)*[a]	*Coastal (commercial)* [b]	*Subsistence* [c]
Cook Islands	0	124*	858*
Fiji	3,909	6,653*	16,600*
Kiribati	6,298 [d]	3,240*	9,084*
Marshall Islands	0	369*	2,000
Micronesia	14,043 [e]	637*	6,243
Nauru	0	279*	98*
Niue	0	12*	103*
Palau	0	736*	750*
Samoa	7,052	106 [f, **]	4,400 [g, **]
Solomon Islands	49,390 [h]	1,150*	10,000**
Tonga	571	1,429*	933**
Tuvalu	0	120*	807**
Vanuatu	38,431 [i]	56 [j]	2,045**

Note: All figures for 1998 unless otherwise noted. * 1995 ** 1997/98

Sources:

a Estimates of industrial fishery production are provided by L. Rodwell, Forum Fisheries Agency (personal communication) based on SPC 1998 provisional landings data.

b Unless otherwise stated, estimates of coastal commercial fishery production are from Dalzell, Polunin and Adams (1996).

c Unless otherwise stated, estimates of subsistence fishery production are from Dalzell, Polunin and Adams (1996).

d Partly caught outside Kiribati waters

e Partly caught outside FSM waters

f Samoa Fisheries Division Annual Report 1997/1998

g Samoa Fisheries Division Annual Report 1997/1998

h Central Bank of Solomon Islands Quarterly Review, June 1999

i Caught almost entirely outside Vanuatu waters

j Vanuatu Fisheries Department, Annual Report 1998

Table B.2. Estimated Annual Value of Pacific Island Fisheries *(in millions of US$)*

Country	*Offshore (industrial)*[a]	*Coastal commercial*	*Subsistence*[b]	*Other*
Cook Islands	0[*]	0.3	3.0	4.5[c]
Fiji	14.2	18.3	45.8	1.7[d]
Kiribati	6.6[e]	4.8	13.4	0.7[f]
Marshall Islands	0	0.7	3.1	0.3[g]
Micronesia (FSM)	13.5	1.5	11.2	0.4[h]
Nauru	0	0.6[**]	0.2[**]	0**
Niue	0	0.05	0.5	0
Palau	0	2.4	1.8	0
Samoa	14.3	0.4[i,***]	13.3 [j,***]	0.01 [k,***]
Solomon Islands	61.3	4.3	8.4	2.8 [l]
Tonga	1.6	2.8	1.9	0
Tuvalu	0	0.1	0.7	0
Vanuatu	39.7	1.7 [m]	2.0	0.9[n]

Notes: All figures for industrial fisheries are for 1998, unless otherwise noted
All figures for commercial, subsistence and other fisheries are for 1995, unless otherwise noted
* 1990 data ** 1996 data *** 1997/98 data

Sources and Notes:

a. Estimates of industrial fishery production value provided by L. Rodwell, Forum Fisheries Agency (personal communication), based on 1998 estimated landings multiplied by estimated average price.

b. Note the revised estimates of fisheries subsistence value for food security in Annex A, Table A.1.

c.

Ornamental fish	US$	171,453
Pearl products	US$	4,346,574

d.

Shells, coral, trochus	US$	1,020,000
Pearl products	US$	79,300
Animal feed	US$	306,900
Aquaculture	US$	250,000

e. Includes value of Kiribati vessels fishing and landing their catch outside Kiribati EEZ

f. Estimated value of aquaculture

g. Aquarium fish exports

h. Exports of coral, shell and trochus

i. Samoa Fisheries Division Annual Report 1997/98.

j. Samoa Fisheries Division Annual Report 1997/98.

k. 'Bio-rock' for aquarium trade. Source: Samoa Fisheries Division Annual Report 1997/98.

l.

Shells, coral and trochus exports	US$	2,518,200
Fish meal exports	US$	235,400

m.

Coastal fisheries - commercial:	US$	1,514,364
'Fish exports'	US$	179,400

n. Shells, coral and trochus exports

Table B.3: Estimated Fisheries Trade in the Pacific Islands

Country	*Imports*		*Exports*	
	Volume (metric tons)	*Value (US$ million)*[a]	*Volume (metric tons)*	*Value (US$ million)*[b]
Cook Islands	195	0.48	96	3.29
Fiji[c]	16,854****	21.5****	13,978	26.3[d]
Kiribati	374	0.4	3,083[e]	3.3[f]
Marshall Islands	83	0.3	731[g]	15.4
Micronesia	1,176**	2.0**	10,885[h,*]	73.6[i,*]
Nauru	–	–	–	–
Niue	–	–	–	–
Palau[j]	792	1.84	44	0.2
Samoa	3,234	3.9	24,405****	9.4****
Solomon Islands	107**	0.24**	34,646***	26.8***
Tonga	604	0.8[k]	–	1.4[l,****]
Tuvalu	–[m]	–	–[n]	–
Vanuatu[o]	1,155****	1.6****	145****	0.9[p,****]

Notes: Estimates are for 1996 unless otherwise stated. *1994 data **1995 data *** 1997 data **** 1998
– Not available.

Sources and Notes:

a Unless otherwise stated, data on import values is from the FAO Statistics Yearbook (Commodities), 1996.

b Unless otherwise stated, data on export values is unpublished information provided by the Statistics Bureau, Secretariat of the Pacific Community.

c Source: Fiji Fisheries Division Annual Report, 1998.

d Includes value of aquarium fish exports .

e FAO Fishery Statistics (185 t) plus all the catch (2,998) taken by industrial fishing activities outside Kiribati.

f Asian Development Bank, 1996. Includes value of Kiribati tuna fishing vessels operating outside Kiribati.

g Entire domestic longline catch (616 t) plus 115 t of exports reported in FAO Fishery Statistics Yearbook (Commodities). This figure may be an underestimate as there may be significant additional exports of fish landed domestically by foreign fishing vessels.

h Entire tuna purse seine catch (10,728 t) plus domestic longline catch (153 t) and 4 t of miscellaneous products reported in FAO Fishery Statistics Yearbook (Commodities).

i Asian Development Bank Social and Economic Indicators for Developing Countries (1997).

j The stated values are almost certainly underestimates.

k 502 tonnes recorded in Government trade balance data, plus the 1,062 t of longline-caught fish recorded in the SPC tuna bulletin.

l Kingdom of Tonga Statistical Indicators 2000. Statistics Department, Nukualofa, Tonga.

m An unknown amount of canned fish, and possibly other seafood products is imported to Tuvalu.

n Exports mainly comprise air consignments of fresh deep-water snapper, estimated at about 100 kg/week, and small quantities of dried reef fish .

o Vanuatu Fisheries Department Annual Report, 1998.

p Value includes fish and seafood as well as beche-de-mer, shells, aquarium fish and shark fins.

Table B.4. Estimated Annual Export of Major Coastal Fisheries Commodities from the Pacific Islands Region

Commodity	*Amount (in metric tons)*
Sea Cucumber	1,500[a]
Trochus Shells	2,000[b]
Pearl Shells	400[c]
Pearls	about 1[d]
Deep-water Snappers	300[e]
Giant Clams	20[f]
Live Groupers	Unknown but growing

Source: Secretariat of the Pacific Community
a. Dried, equivalent to 15,000 metric tons of live weight
b. Shell weight
c. Mainly spent farmed shell
d. With a value of more than US$100 million
e. Mainly from Tonga
f. Of abductor muscle

Table B.5. Estimated Employment in Fisheries in Selected Pacific Island Countries

	Formal Employment by Sector (numbers of people)	
Country	*Commercial harvesting*	*Processing/ Post-harvest*
Cook Islands	40[a]	175
Fiji	6,900	5,000
Kiribati	1,131	N/a
Marshall Islands	200	50
Micronesia	1,150[b]	50
Nauru	25	0
Niue	4	0
Palau	800	—
Samoa	720[*]	80[c, *]
Solomon Islands	1,250	1,546
Tonga	1,051	—
Tuvalu	100	5
Vanuatu	250[d]	10

Notes: — Not available. All data for 1996, except *- 1997.
Subsistence fishers are not included (see Chapter 2 of text).
Sources and Notes:

[a] Gillett (1996). Data relates mainly to Rarotonga, as there are few professional fishermen elsewhere in Cook Islands.
[b] 650 full-time, 500 part-time.
[c] A further 3,500 Western Samoans are employed at the two tuna canneries in neighboring American Samoa, 7% of whose fish supply is imported from Samoa.
[d] Does not include crew on foreign fishing vessels operating outside of Vanuatu.

Table B.6. Estimated Per Capita Fish Consumption in Pacific Island Countries

Country	*Commodity balance (metric tons)*[a]				*Apparent per capita supply (kg/yr)*
	Production	*Imports*	*Exports*	*Total supply*	
Cook Islands	1,109	195	96	1,208	63.2
Fiji	35,200[b]	17,533	13,244	39,489	50.7
Kiribati	15,222	374	3,083	12,513	150.0
Marshall Islands	2,985	83	731	2,337	38.9
Micronesia	17,761	1,176	10,885	8,052	72.0
Nauru	376	—	—	376	35.9
Niue	115	—	—	115	54.8
Palau	1,486	70	16	1,540	85.1
Samoa	6,446	3,234	1,772	7,908	46.3
Solomon Islands	64,771	107	36,271	28,607	32.7[c]
Tonga	3,424	604	1,562	2,466	25.2
Tuvalu	927	—	—	927	85.0
Vanuatu	2,512	1,316	113	3,715	21.0
Total				109,253	33.82

Notes: — Not available.

[a] Production, Import and Export tonnages have been converted to live weight equivalent using FAO conversion tables.

[b] An additional 10,000 metric tons of fish meal are noted as having produced. However, fish meal in Fiji is produced from tuna canning waste and may therefore already be included in the 'Fish for direct human consumption' production figure.

[c] After accounting for fishmeal exports.

Table B.7: Estimated Current and Projected Future Costs of Fisheries Management and Administration *(in US$'000)*

Obligations	*Current Costs of Current Activities Funded by*			*Estimated Costs of Future Activities with MHLC Convention Funded by*		
	DWFN	*Aid*	*PICs*	*DWFN*	*Aid*	*PICs*
Regional Monitoring, Control and Surveillance:						
- Installation of Vessel Monitoring System	*5,000*	--	--	*6,000 a)*	--	--
- Operation of Vessel Monitoring System	850	--	350	1,700	--	350
- Air Surveillance	--	5,000	--	--	5,000	--
- Surface Surveillance Investment Costs	--	*120,000*	--	--		--
- Surface Surveillance Operation Costs	--	3,000	3,000	--	3,000	3,000
- Observer Program	250	250	1,000	3,050	250	1,000
- Regional Register of Vessels	500	--	20	500	--	20
Regional and National Tuna Research:						
- Regional Research by SPC	--	1,800	--	900	1,800	--
- Other Research	--	--	500	800	--	500
- National Research	--	--	--	--	--	--
Data Collection:						
- Catch and Effort of DWFN	400	--	--	1,000	--	--
- Catch and Effort of Local Fleet	--	--	400	--	--	800
- Economic Data	--	20	100	--	20	100
- Compliance	--	20	100	--	20	100
Legal Requirements						
- Review	--	--	--	--	250	350
- Updating	--	50	--	--	50	50
Preparation for MHLC	*750*	*1,500*	*200*	--	--	--
Finalizing MHLC and Commission	*750*	*1,500*	*200*	--	--	--
Overhead MHLC						
- Annual Meetings	--	--	--	150	--	150
- Data Dissemination	--	--	--	100	--	50
- Secretariat	--	--	--	500	--	500
- Scientific Committee	--	--	--	75	--	75
- Technical Committee	--	--	--	75	--	75
Fisheries Administration						
- Annual Reporting	--	--	500	500	--	1,000
- Training and Maintenance of Staff	--	500	500	--	600	600
- Updating Equipment	--	500	500	--	*1,000*	*1,000*
Total Investment Costs (in italics)	*6,500*	*123,500*	*900*	*6,000 a)*	*1,000*	*1,000*
Total Operating Costs	2,000	10,190	6,470	9,350	10,990	8,750

Source: van Santen and Muller (2000) based on data from the Forum Fisheries Agency (FFA).
a) US$ 8 million if a new Vessel Monitoring System (VMS) was to be installed.
Regional Monitoring, Control and Surveillance, Current Costs: VMS installation of transponders: US$4,000 per vessel for 1,000 vessels; equipment at FFA center and national stations, US$1 million. VMS operational costs include US$350,000 for FFA center and US$850,000 for 16 national stations. Aerial surveillance covers 1,000 hours at US$5-24,000/hour. Surface surveillance investment comprises 22 patrol boats at US$5.2 million each and others with running costs of about US$260,000 per annum each.
Observer program: regional program costs US$250,000 per annum. Costs covered by distant water fishing nations (DWFN) estimated to be the same. National observer programs are estimated to cost US$1 million for all Pacific Island countries.
Monitoring, Control and Surveillance, Future Costs: VMS installation costs assumes existing FFA VMS would cater for all vessels fishing in EEZ and high seas. Investment costs include upgrading of existing equipment and expansion of number of vessels to 2,000 (US$3 million), upgrading of equipment at FFA Headquarters, the Commission Headquarters, and National Stations (US$3 million).
VMS operating costs would double for DWFNs to include entire fleet operating in EEZ and oceanic areas. Air and surface surveillance costs would remain at current levels. DWFN observer programs would substantially increase in scope to cover those vessels that operate in high seas. Regional Register costs would remain the same.
Research, Current Costs: estimates for SPC (US$1.8 million) and US$500,000 for all national efforts.
Research, Future Costs: A 50% increase in SPC research costs is assumed to cover high sea areas, to be funded by DWFN; DWFN research requirements would increase by an estimated US$800,000 annually.
Data Collection, Current Costs: estimated at US$25,000 per Pacific Island country; DWFN expenditure assumed to be similar amount.
Data Collection, Future Costs: Requirements will at least double (for PIC) and are estimated to increase 150% for DWFNs.
Legal Requirements, Current Costs: Actual average over several years, to reduce the impact of particularly high costs in recent years.
Legal Requirements, Future Costs: Estimated to require US$40,000 per country, including direct legal support and associated costs of introducing additional legislation.
Preparation of MHLC: actual data.
MHLC Administration Costs: based on current estimates.
Administration Costs, Current Costs: based on US$30-40,000 per PIC for reporting and twice that amount for staff development and updating equipment.
Administration Costs, Future Costs: for DWFN, costs are estimated to increase to accommodate reporting requirements, and double for Pacific Island countries. Staff training costs will increase, and equipment costs for Pacific Island countries will double.

Table B.8. Summary of Marine Mineral Resource Potential of Pacific Island Countries

Country	*Coastal minerals*	*Deep-sea minerals*
Cook Islands	Poor	Very Good
FSM	Poor	Moderate
Fiji	Producing	Good
French Polynesia	Moderate	Good
Guam	Poor	Poor
Kiribati	None	Moderate
Marshall Islands	None	Good
New Caledonia	Producing	Poor
Niue	Poor	Unknown
Western Samoa	Poor	Poor
Islands	Producing	Moderate
Tonga	Poor	Good
Tuvalu	None	Moderate
Vanuatu	Good	Moderate

Source: SOPAC Medium Term Plan (1996)